# Cartography in Croatia 1991–1999

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The paper gives the review of the cartographic activity in Croatia from 1991 till the end of 1999. The review is a compilation of two national reports that have been submitted to the General Assembly of the International Cartographic Association held in Barcelona (1995) and Ottawa (1999). Some additional facts, unknown to the authors at the time of writing the reports, have been included as well.

*Keywords:*
map, mapping, cartography, Croatia

## 1 Introduction

On 25th June, 1991 the Croatian Parliament took the decision to break all relations with Yugoslavia and declared Croatia to be an independent and sovereign state.

*The Union of the Geodetic Societies of Croatia* decided on 12th November, 1991 to detach itself from the *Union of Geodesy Engineers and Surveyors* of former Yugoslavia, and on 25th May, 1993 *the Croatian Geodetic Society* was founded. Within the scope of the Society, the *Section for Cartography* was also founded, gathering together all cartographers from throughout Croatia. Through the Section for Cartography, Croatia was accepted in the International Cartographic Association at its 10th General Assembly held in 1995 in Barcelona.

The national report was submitted then, and also a new one was submitted at the 11th General Assembly held in 1999 in Ottawa. This paper is a compiled and revised version of the two reports, giving the data on maps that Croatia had at its disposal, on cartographic institutions and their activites in the period 1991–1999. The paper presents the data pertaining to the official topographic and thematic maps, charts, databases and geoinformation systems. It also presents the activity in the field of commercial and academic cartography and publishing activity and gives a short description of map exhibitions.

## 2 Official cartography

### 2.1 State Geodetic Administration

The production of the topographic and cadastral plan at the scales of 1:500, 1:1 000, 1:2 000 and 1:2 500 and of the Croatian Base Map at the scale of 1:5 000 was conducted in Croatia by the Administration for Geodetic and Cadastral Affairs, being the integral part of the Ministry for Civil Engineering and Environmental Care. This Administration was later renamed the State Geodetic Administration of the Republic of Croatia (Državna geodetska uprava Republike Hrvatske) which is competent, among other things, also for official cartography. As under the previous Administration, the new State Geodetic Administration has no production section. Official plans and maps in Croatia are mainly produced by the Company for Photogrammetry in Zagreb, in the Geodetic Companies in Rijeka, Split and Osijek, on the basis of orders submitted by the State Geodetic Administration.

The State Geodetic Administration also has within its competence the production of topographic maps at the scale of 1:25 000 and smaller scales, which used to be held by the Military and Geographic Institute in Belgrade.

#### Topographic and cadastral plans

Topographic and cadastral plans are today available only for one fifth of the state territory and they are made at the following scales:

- at the scale of 1:500 for old city centres and certain smaller areas
- at the scale of 1:1 000 for towns and larger settlements
- at the scale of 1:2 000 and 1:2 500 for poorly built-up and agricultural area.

For the remaining part of the state territory there are still only cadastral plans at the scale of 1:2 880 (exceptionally 1:2 904), originating from the graphical survey made of the territory of the Habsburgs Monarchy in the last century. The cadastral plans of the graphical survey do not show the level control of the land.

The contents of the topographic and cadastral, (and especially cadastral plans), do not always or fully reflect the real situation in the field because they are not regularly updated.

### Croatian Base Map

A Croatian Base Map (Hrvatska osnovna karta – HOK) at the scale of 1:5 000 has been made in the last fifty years to cover more than 70% of the territory of the Republic of Croatia. A large part of the material has become obsolete, as not much attention has been given to its maintenance and updating.

The Company for Photogrammetry from Zagreb has made 18 sheets of the Croatian state map 1:5 000, ordered by the State Geodetic Administration, using digital methods and in collaboration with the firm, "Geofoto". The map sheets are made on the basis of the photogrammetric survey at the scale of 1:10 000 and processed by means of photogrammetric stereo-instruments using Microstation software.

### Topographic and general maps

From the period of the First World War, cartographic activity has been connected with the military institutions outside of Croatia, so all the publication of topographic maps stated below, was carried out by the Military and Geographic Institute in Belgrade. Topographic maps up to the scale of 1:300 000 inclusively are made in Croatia in 3° zones of the Gauß-Krüger projection. The scale at the central meridian is 0,9999.

Further in the text will be found data about the topographic maps of Croatia. The map contents of single parts of Croatia reflect the situation of the landscape according to the years given in parenthesis (28):

Topographic map 1:25 000 (TK 25):

- South Dalmatia, from Makarska to Prevlaka, (1971–1973)
- Istria, Gorski Kotar and the territory of Kvarner (1974–1976)
- the border with Slovenia (1984–1986)
- the rest of the territory (1977–1979).

Topographic map 1:50 000 (TK 50):

- Istria, Gorski Kotar, Lika and northern Dalmatia (1978–1979)
- the border with Slovenia (1985–1986)
- the rest of the territory (1980–1981).

Topographic map 1:100 000 (TK 100):

- West Croatia (1979–1981)
- East Croatia (1982–1984).

Topographic map 1:200 000 (TK 200):

- East Croatia (1984)
- West Croatia (1985).

General map 1:300 000 (1984–1985).

General map 1:500 000 (in Lambert's conformal conical projection, 1989).

For all above mentioned maps from the scale of 1:25 000 to 1:500 000, the publishing and fair draughts can be found in the Military and Geographical Institute in Belgrade. Croatia has only a smaller number of printed maps. Therefore, at the end of 1994, the State Geodetic Administration ordered, the elaboration of the *Study on the substitution of fair draughts and renewal of topographic maps*, suggesting a new method for updating and the reproduction of topographic maps. The elaboration of the study was lead by the firm, "Geofoto" from Zagreb in collaboration with the Faculty of Geodesy, Zagreb, "Landestopographie" from Bern, "ITC" from Enschede and the Institute for Photogrammetry, Zagreb (11).

The first temporary issue of the topographic map 1:25 000 (TK25) was made from the available multicolour printed fair draughts using the reproduction methods. Also produced were new, partly supplemented sheets with somewhat changed terminology and marginal information. The contents of the fair draughts of each single sheet could be reached in digital raster format with the resolution of 300 dpi.

The Croatian digital topographic map at the scale of 1:25 000 (HTZ25) for the areas of especially explicit economic interest was produced as a priority. The contents are structured during the photogrammetric survey in accordance with the catalogue of object types (classes) defined by the data model CROTIS (Croatian Topographic Information System). The height presentation is made in the format DMR 25/1 and is harmonised with the corresponding DMR 5/0 and DMR 5/1, resulting from the work on the digital topographic map 1:25 000 by digitising the existing map 1:5 000 and by making the digital Croatian Base Map (HOK).

The Croatian Base Map in digital form at the scale 1:5 000 is made for the area of explicit economic interest. The contents are structured during the survey in accordance with the catalogue of topographic objects and types. The height presentation is made in the format DMR 5/1. HOK is used as a conventional map on paper or foil, and as the digital topographic basis for all adequate geoinformation systems. The file format is DGN/DXF for topographic contents and SCOP-DTM for height presentation (25).

The State Geodetic Administration of the Republic of Croatia started to work on establishing and managing the evidence on the state borders of the Republic of Croatia with Slovenia, Bosnia and Herzegovina and the Federal Republic of Yugoslavia at the beginning of 1992. The borderline is presented on the maps 1:5 000 (812

sheets), 1:25 000 (158 sheets) and 1:100 000 (43 sheets). The data on the borderline are contained in the documents *Description of the border and border plans* in analogous and digital format.

The official evidence of administrative units (Službena evidencija prostornih jedinica – SEPJ) is the basis for all geoinformation systems. The work on SEPJ lasting several years has resulted in the establishment of the alphanumerical and graphic databases of administrative units. Today, the SEPJ data are an integral part of the data on the territorial establishment of the European countries. It was realised through international collaboration within the framework of the European organisations CERCO (*Comité Européen des Responsables de la Cartographie Officielle*) and MEGRIN (*Multipurpose European Ground Related Information Network*), and through the participation in the project SABE (*Seamless Administrative Boundaries of Europe*).

### 2.2 Department for Geodesy, Surveying and Mapping in the Engineering and Environment Protection Administration at the Ministry of Defence

The Department for Geodesy, Surveying and Mapping in the Engineering and Environment Protection Administration at the Ministry of Defence (Odjel za geodeziju, izmjeru i osiguranje zemljovidima pri Upravi za graditeljstvo i zaštitu okoliša Ministarstva obrane Republike Hrvatske – MORH) is concerned with the topographic maps to be used by the Croatian army.

From 1992 until 1995, 270 sheets of the map 1:25 000 were scanned and reproduced in four-colour printing. During this reproduction, the contents of the maps were not updated.

In the period 1995–99, MORH has continued the procedures of facsimile publishing of topographic and general maps. The procedure of facsimile publishing has been improved by introducing digital processing of all elements of scanned maps. Thus, there were 419 maps made in the above mentioned period and printed in editions of large numbers of copies.

Apart from the facsimile publishing of topographic and general maps, MORH has published a new general map of the Republic of Croatia at the scale of 1:500 000 in the Lambert conformal conical projection and in digital form. The project of making the military topographic map at the scale of 1:25 000 is on-going, and there are 18 sheets covering the area of the City of Zagreb with the surroundings planned to be made in the first phase. Due to computer possibilities and also because of the necessity of its being congruent with the official state maps and the maps in the NATO cartographic system of the same scales, the map will be made in two versions. These two versions are distinguished by projection, ellipsoid, presentation format and marginal contents.

Regarding the provision of hydrographic data and material needed by the Defence Department, MORH has published in paper and digital form a military navigation manual, first part (from Savudrija to Zadar) and second part (from Zadar to Prevlaka). The manual contains textual and graphic data about harbours, piers, anchorages, bays, marinas, passages, masked berths and areas containing mines, and other data of interest for defence pruposes.

For the purpose of aviation, MORH has published the second issue of the military aeronautical chart at the scale of 1:500 000 in the Lambert conformal conical projection in paper form. A new military aeronautical chart in the same projection in paper and digital form is being prepared.

Apart from the topographic and general maps, sea charts, manuals, and aeronautical charts, MORH has published, or started to work on, various thematic maps and other cartographic material such as the *Map of county districts, cities and municipalities* at the scale of 1:500 000 2nd edition, the *Map of the military divided areas* at the scale of 1:500 000, the *Map for orientation running* in the area of Jastrebarsko, general sheets for military maps at the scale of 1:25 000, 1:50 000, 1:100 000, 1:200 000 and 1:300 000. The production of the relief wall map of the Republic of Croatia at the scale of 1:500 000 has begun.

For the purpose of providing the data in digital form, in the period 1995–99, MORH started work on the Spatial information system of the armed forces of the Republic of Croatia (Prostorni informacijski sustav oružanih snaga Republike Hrvatske – PISOSRH) required for defence purposes. The system is based on digital raster military maps at the scale of 1:25 000, 1:50 000, 1:100 000, 1:300 000 and 1:1 000 000. Along with the above mentioned maps PISOSRH contains: digital raster satellite and air photographs, vector thematic maps, digital terrain model, database of inhabited settlements, demographic data of the Republic of Croatia, database of trigonometric points in the Republic of Croatia and relevant parts of neighbouring countries, graphic, numeric, image data about civil structures important for defence (bridges, tunnels, roads etc.), graphic, numeric and image data about military structures, etc.

### 2.3 State Hydrographic Institute

The only institution which makes and publishes the nautical charts in Croatia is the Croatian Hydrographic Institute (Hrvatski hidrografski institut, former State Hydrographic Institute).

According to their scale, content and purpose, nautical charts are divided as follows:

*General charts* show the area of the Mediterranean Sea with a part of the Black Sea, the Adriatic Sea and the Ionian Sea at the scale of 1:750 000 to 1:2 500 000.

*Sailing charts* show the area of the Adriatic Sea, Ionian Sea and Maltese Islands at the scale of 1:150 000 to 1:300 000.

*Coastal charts* show the area of the Adriatic Sea – eastern coast at the scale of 1:50 000 to 1:100 000. They include *Small charts* at the scale of 1:100 000, which are small-sized and suitable for smaller vessels. They are available only in sets.

*Plans* show major ports and marinas, bays, coves and passages of the eastern Adriatic coast at the scale of 1:3 000 to 1:40 000.

Informative charts include particular information important for navigation in the Adriatic Sea:

*Bathymetric chart* show the depths of the Adriatic Sea at the scale of 1:1 000 000.

*Sedimentologic charts* (atlas) show the nature of the bottom of the Adriatic Sea at the scale of 1:1 000 000, 1:750 000 and 1:100 000.

*Climatological Atlas of the Adriatic Sea* includes mean monthly values of oceanographic and meteorological parameters: air temperature and surface temperatures of the sea, frequency of the wind direction and strength, relative air humidity, cloud and precipitation.

*Auxiliary charts* show parts of the Adriatic Sea at the scales of 1:300 000 to 1:500 000. They are used for graphic solutions of certain tasks in navigation and are suitable for coupling.

*Navigational handbooks* provide information which cannot be represented on charts, and yet is important for the safety of navigation. When information on a chart disagrees with the information in the handbook, the more recent information is applied, and the more unfavorable information is given as a precaution. Handbooks are published as occasional publications (Sailing Directions, List of Lights and Fog Signals, Nautical Tables, Radio Service), or periodicals (Nautical Almanac, Tide Tables).

The Hydrographic Institute in Split is competent for the production and management of sea charts and plans for the area of the Adriatic Sea, the Ionean Sea and the Maltese islands. In recent times the Hydrographic Institute has started to make sea charts and plans in raster format and to distribute them on CD. For the purpose of perusing and using raster maps, the software Rugavi, Telchart and Arc Info are used. Raster charts (RNC) along with the software for their usage are a temporary phase in the technology of making electronic charts (ENC) and information systems of electronic charts (ECDIS) that began to be developed in this institution according to the recommendations of the International Hydrographic Organisation (IHO), the International Maritime Organisation (IMO) and the International Organisation for Defining Navigable Lines.

The Cartographic Department of the Hydrographic Institute has published a few maps (the plan of Plomin), and a few plans in various publications and studies, (Catalogue of maritime maps and publications, Peljar, List of lights and Signals for fog). These were made in digital format using MicroStation Mapping Office, Freehand 8 and other graphic software.

### 2.4 Geological Research Institute

The Geological Research Institute (Institut za geološka istraživanja) in Zagreb was founded in 1909 under the title *Geologijsko povjerenstvo za Kraljevine Hrvatsku i Slavoniju*. Today, the Institute is staffed by 120 scientists, engineers and technical staff and is divided into three departments: the Department of Geology and Palaeontology, the Department of Hydrogeology and Engineering Geology and the Department of Petrology and Minerals.

The general geological map (Osnovna geološka karta – OGK) of the Republic of Croatia was a project conducted according to the unique methodology for the entire area of the former Yugoslavia. The Geological Research Institute, Department for Geology and Palaeontology was responsible for the project. This institution that was founded on 3rd July 1909 by the decree of the Croatian, Slavonian and Dalmatian State government, has dealt with the production of geological maps on the territory of Croatia since it was established.

Organised research began in 1958, and the project was completed in 1985. OGK can be defined as outstanding work for the Republic of Croatia, providing the geological map, a very much needed basis for all planning activities in geology, mining, civil engineering, forestry,

water supply, agriculture and other economic branches.

There were 73 sheets made and printed together with accompanying data memoirs. However the last seven and final sheets accompanied by a complete documentation remained in the former Federal Geological Institute in Belgrade and will be sought in the succession procedure.

Regarding the very complex geological structure of the Croatian soil, the Croatian geological science establishment is permanently employed in the systematic and organised gathering of material and in processing and interpreting that data. The geological map of the Republic of Croatia at the scale of 1:50 000 is presently being produced. This map is actually the second phase in the production of the General Geological Map of the Republic of Croatia.

The most important part of the procedure in the production of the geological map is mapping carried out in the scale of 1:25 000, 1:10 000 or 1:5 000, depending on the purpose or object of research.

Along with the above-mentioned geological map of the Republic of Croatia 1:50 000, there are also other thematic maps researched in the Geological Research Institute, having had their origin in the General Geological Map. These are as follows:

- General Hydrogeological Map of the Republic of Croatia 1:100 000 in the Institute of Engineering Geology and Hydrogeology
- General Engineering Geological Map of the Republic of Croatia 1:100 000 in the Institute of Engineering Geology and Hydrogeology
- Map of Mineral Resources and Forecast Map of the Republic of Croatia 1:100 000/ 1:200 000 in the Institute for Mineral Resources
- Geochemical Map of the Republic of Croatia 1:100 000 in the Institute of Mineral Resources
- Geothermal Map of the Republic of Croatia 1:100 000 in the Institute of Geology
- Structural and Geomorphologic Map of the Republic of Croatia 1:100 000 in the Institute of Geology.

At the beginning of 1990s, the geoinformation system for hydrology was begun. This enabled the much quicker and more purposeful interpretation of field research, as well as simpler changes needed for new findings. The instructions, and standards, according to which the research for the *Basic Hydrological* and *Basic Engineering and Geological Map* of the Republic of Croatia were initiated, are adjusted to GIS following the Arc/Info method. The advanced technology helped in making a very demanding legend (signs, lines, raster) so that today a cartographic presentation of hydrological, engineering and geological map, or the map of minerals by means of ink printer or plotter replaces almost completely the classical print. By June 1999, the following sheets of the Basic Hydrogeologic and Engineering and Geological map at the scale 1:100 000 (30'×20') and the Maps of Minerals also at the scale of 1:100 000 (30'×30') were made:

- Hydrogeologic – Zagreb (1996), Ivanić Grad (1999), Rijeka (1996), Split (1997), Trieste (1999), Rovinj (1999), Pula (1999), Labin (1999), Cres, Molat (1998), Silba (1998), Biograd (1998), Vis (1998), Jelsa (1998), Korčula (1998), Lastovo (1998), Ston (1998)
- Engineering and Geologic – Zagreb (1998), Ivanić Grad (1999), Rogatec (1998)
- Minerals – Rovinj (1998), Split (1998), Požega (1999)

Along with the above-mentioned basic projects, there are also many studies and projects made in the Institute resulting in maps. The following studies were made: GIS of the river Drava 1:100 000 and 1:25 000 (1995–97), The basis of water economy of the Republic of Croatia 1:300 000 (1996–97), Hydrogeologic map of Istria 1:100 000 (1999), and Hydrogeologic study of the Dalmatian Islands 1:100 000 (1998), Hydrogeologic map of the Republic of Croatia 1:300 000 (1996). Within the scope of the engineering and geologic studies, the Engineering and Geologic map of the Republic of Croatia was made at the scale of 1:300 000 (1998), various projects of tunnels and highways at the scale of 1:1 000 and 1:5 000 (1997–99), and at the moment, the production of engineering and geological documentation at the scale of 1:2 500 for regional airports on the Middle Dalmatian Islands is in its final stage (Hvar, Korčula, Vis and Lastovo).

### 2.5 City Office for Cadastral and Geodetic Affairs in Zagreb

On the basis of the initial experiences acquired through the test work with different tools, through insight and getting acquainted with the situation referring to GIS technologies and their application in the western, developed countries, the Zagreb City Office for Cadastral and Geodetic Affairs (Zavod za katastar i geodetske poslove grada Zagreba) has made, in collaboration with the City Office for Automatic Data Processing, the necessary documentation

and invited the tenders for programme and computer equipment necessary to establish the GIS of the city of Zagreb. GIS of the city of Zagreb is developed within the frame of the project *Digital model of the land register* using the programme package SYSTEM/9 (UNISYS V. 5.3.) (29). Sun's SPARC center 2000, located in the data processing center, is a data server for ten SUNSparc and twenty PC workstations across the city. The data processing center of the city of Zagreb acts as a central database, training center and applications developing center. The Central Cadastral Office and Planning Department have been the centres for data acquisition, various analyses, plotting centres and public services (2).

Within the scope of the City of Zagreb GIS, the projects *Unique spatial units register* and *Digital land register* are being prepared. The Unique spatial units register is being made on the basis of 360 sheets of the Croatian State Map 1:5 000 and it encompasses 136 cadastral municipalities, 316 settlements, 334 local communities, 5 000 census circles, 7 000 streets and squares, 200 000 buildings and house numbers (3). All 360 sheets have been scanned and transformed into the vector form, and the database for about 15% of the planned contents is finished. Within the frame of the project, "Digital land register", 33 cadastral plans at the scale of 1:1 000 of the municipality of Trnje have been scanned and vectorised.

## 3 Commercial cartography

### 3.1 Cartographic Laboratory Križovan (KLK)

"KLK" ("Kartografski laboratorij Križovan") is a small private firm founded in 1991. It started to work actively in 1992. They have made a number of significant cartographic products. The Road Atlas of Croatia (with Slovenia and Bosnia and Herzegovina included), with maps at the scale of 1:1 000 000, was published in 1992. In 1995 the Road and Tourist Map of Istria and Cres-Lošinj, at the scale of 1:110 000 was published.

On the basis of the acquired experiences, KLK began to produce maps by using computers at the end of 1995. It makes topographic, general and thematic maps, and presentations related to maps. In collaboration with the Faculty of Geodesy, University of Zagreb, "KLK" works on researching the method of producing and supplementing the topographic map 1:25 000 (TK25), on the basis of the existing cartographic material. On the basis of an agreement with the Ministry of Defence, the first 18 sheets for the territory of Zagreb are being prepared.

The General Map of the Republic of Croatia as ordered by the Ministry of Defence at the scale of 1:500 000 was made and is prepared for the ten-colour printing. The data of the map are saved in 160 various layers in the vector format.

The largest part of the map production in the firm "KLK" are thematic maps. The most numerous among them are road and tourist maps, followed by political, school, forest and economic, climate, geological, vegetation and other maps. The most distinguished among them are Istria, Krk-Cres-Lošinj, Dalmatia, at the scale of 1:100 000, The County of Primorje and Gorski Kotar 1:150 000, The County of Varaždin 1:110 000, and The County of Zagreb 1:115 000.

"KLK" is working on the production of atlases as well. So far it has made the World Atlas with 210 thematic maps, containing 247 pages in the format of 25×18 cm, and the School Atlas of Croatia on 65 pages of exclusively cartographic material, in the format of 32×21 cm.

"KLK" has also established a good working relationship with the cartographic house, "Freytag & Berndt" of Vienna, for which it has made road and tourist maps of Istria and Dalmatia at the scale of 1:100 000 in the B1 and A0 formats. These maps are sold all over Europe.

### 3.2 Company for Photogrammetry d.d. Zagreb

The "Company for Photogrammetry", Zagreb (Zavod za fotogrametriju d.d.) produced the database of the political and territorial division of the Republic of Croatia on the basis of the order submitted by the State Geodetic Administration, digitizing the maps at the scales of 1:25 000 and 1:100 000.

For some time now, the "Company for Photogrammetry" has participated in the establishment of the information system for road management, run by the public enterprise "Hrvatske ceste" ("Croatian Roads"). Within the scope of this very complex project, the fundamental database for roads has been created and additionally supplemented with basic data about the land. On this basis various thematic maps have been made which should primarily make the work on the categorisation and classification of roads in Croatia easier. The information side of the project referring to the use of the programme package ARGIS is supported by the firm "TEB-Inženjering" from Zagreb.

In 1992, the "Company for Photogrammetry" in collaboration with the Institute for Cartography at the Faculty of Geodesy, has made the *Study on the establishment of the Official Topographic and Cartographic Information System of the Republic of Croatia*, as ordered by the State

Geodetic Administration (Administration for Geodetic and Cadastral Affairs 1992). This year the same institutions have finished the *Designing Project of the Official Topographic-Cartographic System*. In the elaboration of this project the German Amtliches Topographisch-Kartographisches Informationssystem (ATKIS) has been taken as the model (28).

In the period 1995–99, the "Company for Photogrammetry" has invested immense sums in order to provide new equipment and to modernise existing equipment. Among other things, a large format ink plotter has been bought (Calcomp TechJet 5336) and was later replaced by a more recent model (5536). Several program packages for GIS, digital mapping and photogrammetry were bought: Arc View, Intergraph Map-Office, Intergraph GIS-Office, CadOverlay, Scop, Scop-DOP.

On the basis of digital data gathered in the company, the fair draughts were made for printing the general map of the Republic of Croatia at the scale of 1:300 000, as ordered by the State Geodetic Administration, at the scale of 1:300 000. Along with the topographic contents, there were also layers made of cadastral municipality borders, administrative units, then the division into the sheets of topographic maps etc.

On the basis of the aerial photographs, 18 sheets of the Croatian Basic Map at the scale of 1:5 000 were made in digital format for the area of Zagreb-South. Orthophoto maps were made in the same scale.

There were 12 sheets of the new topographic map at the scale 1:25 000 (HTZ25) made on the basis of aerial photographs for the area of the western Istria. The sheets were made by means of digital methods and plotted by ink plotter. The preparation for printing will be made later. For the purpose of producing these sheets, the legend has been made with the presentation and dimensions of all map symbols.

The maps of the following county districts were also made and printed: Varaždin, Krapina and Zagorje, Bjelovar and Bilogora, Virovitica and Podravina, Sisak and Moslavina, Karlovac, Koprivnica and Križevci, Lika and Senj, and Zagreb. The last two are made digitally, and the rest of them have been made partly classically.

### 3.3 Croatian School Cartography

The Croatian School Cartography (Hrvatska školska kartografija, earlier Kartografija-Učila) was formed in 1947 and employs about 20 people. The basic activity of this institution is school cartography. Within its scope, wall maps and globes, geographic and historical atlases, as well as reference maps are produced.

In the period 1991–95 the Croatian School Cartography has managed to follow the syllabus with its new contents in the geographic atlases for primary and secondary schools. The atlas *Croatian Historical Maps* which illustrates the past of Croatia in its historical frame has been produced. The wall maps: The Republic of Croatia – physical map 1:500 000, Territorial constitution of the Republic of Croatia 1: 500 000, Croatian cultural and historic monuments, Mountainous Croatia 1:130 000 have also been produced. The wall maps of Europe at the scale of 1:300 000 and Asia at the scale of 1:10 000 000 have been made as well.

In the last five years the Croatian School Cartography has made the following new maps: The Republic of Croatia, physical wall map, 1:300 000 (1996), North-Western Croatia, physical wall map, 1:130 000 (1996), Eastern Croatia, physical wall map 1:130 000, Croatia at the Time of King Tomislav, historical wall map, 1:500 000 (1996), Croatian historical maps, and wall historical map (1997).

At the same time the Croatian School Cartography has been working on constant issues that have to be updated every year and prepared for printing: Geographic Atlas for the Primary School, Geographic Atlas for High Schools, Croatian Historical Maps and Historical Atlas.

### 3.4 GEOdata d.o.o., Split

The company "GEOdata" was founded in 1993. It offers services in the domain of geoinformation systems, cartography, surveying and mapping, as well as development of new related technologies. "GEOdata" presently has eight employees: one MSc of geoinformatics, four BSc and three technicians. Their average age is 30 years.

"GEOdata" has joint projects with similar companies in Croatia and Germany, and is in contact with experts in the Netherlands and the USA.

Major users are The County of Split-Dalmatia, The County of Zadar, The County of Dubrovnik-Neretva, The County of Šibenik-Knin, The Croatian Electricity Company, The Energy Institute Ltd., The Croatian Water Resources Company, The Faculty of Civil Engineering in Split, Ministry of Culture, The Airport of Split, and The MAG Instruments, Inc. USA.

### 3.5 Geodetic Company Osijek

The firm was founded in 1947 under the title *Geopremjer*. From 1968 it has been active under

the title "Geodetic Company" (Geodetski zavod), transformed later into the joint-stock company. It employs 45 workers, 35% among them being geodetic engineers, and 33% geodetic technicians. The Geodetic Company is organised into the 5 sectors: plane surveying, engineering geodesy, automatic data processing, photogrammetry, and administration.

The Department of Automatic Data Processing deals with the computer processing of all data gathered during field measurements, with production of digital relief models (DMR) and geographic information systems (GIS), and with the production of cadastral plans and city plans. The Geodetic Company is one of the pioneers in Croatia in establishing GIS and DMR. So far it has made the GIS of Tvrđa (fortress) in Osijek, Antunovac and Čepin with cadastral data, and the GIS of traffic accidents in Čepin. It has produced the city plan of Osijek and Đakovo, and the map of the County Osijek and Baranja.

### 3.6 Geofoto d.o.o.

The firm began work in 1993 as the first Croatian agency for aerial photography. Apart from photogrammetric surveying, it is especially active in the area of digital mapping, analytical photogrammetric restitution and establishment of geoinformation systems. It employs 22 permanent workers and two persons working temporarily. It has three departments.

The Department for Aerial Photography has two aircrafts, a Turbo Piper Aztec and Antonov An-2, the camera Leica RC20/30 and the most recent photolaboratory in Croatia for the processing of black and white, colour or infra colour photographs.

The Photogrammetric Department is the basis for quick and large-scale data gathering using the methods of analytical and digital photogrammetry.

The Department for Geoinformation and Cartography has the basic activity of working on standards, conceptual modelling, establishment of information systems, digital orthophoto and informatized mapping at small and large scales.

With the existing organisation, equipment and experts, the firm is able to offer a complete service from modelling, designing and gathering the data to presentation in analogous, digital or the form of geoinformation systems. The introduction of quality control according to the standards ISO 9001 and the establishment of standards in surveying guarantees the high quality service.

Further in the text, some of the most important products of the firm Geofoto are listed. Nine sheets of the Croatian Basic Map 1:5 000 were made for the area of Brijuni and 53 sheets for the area of Zagreb. There were also 63 sheets of digital orthophoto made for the wider area of Zagreb at the scale of 1:5 000 and four sheets of the Čakovec area. The orthophoto contains the terms, roads and water lines in the vector format. It has found its special application in the production of *Master Plan*, and as the basis in establishing geoinformation systems. As the basis for the computer aided design of the highway Ljubljana-Zagreb, a digital terrain model has been made by restitution of aerial photographs. The digital records are in vector format (3D).

According to the order of the State Geodetic Administration, the Croatian Topographic Map was made for various areas at the scale 1:25 000 accompanied with the relief presentation using shading, as well as *The study of substituting the fair draughts and restoring topographic maps to middle and smaller scales.*

### 3.7 Gisdata d.o.o.

"Gisdata" is a privately owned company specialising in providing its customers with geoinformation systems, technologies and services. Since 1989, "Gisdata" has designed, supports and provides Geographic Information Systems – GIS, remote sensing and GPS solutions for its clients, primarily in Croatia, Slovenia, Macedonia and Bosnia-Herzegovina, and all the countries of the former Yugoslavia. "Gisdata" can claim that it was one of the pioneers of modern GIS in Central and Eastern Europe, and is the leader today. "Gisdata's" unique position is that it does not only provide one technology system (GIS software from Esri), but it can supply the client with the full range of GIS/RS/GPS technologies, related HW/SW and system integration of its own SW products, consulting, training, data sources, database development services, etc.

"Gisdata" is a long-time authorised and successful distributor for the following geo-technologies: Esri GIS software, Erdas remote sensing/image processing software, Trimble navigation GPS equipment and software, Vision international digital photogrammetry software, Spot Image satellite imagery, KVR 1000 Russian satellite imagery, Landsat satellite imagery and Laser Technology equipment. It also offers its own software products: GeoServer, ArcLink, GeoCalc, TGS, AVT, Digital atlases on CD ROM (B&H, Croatia, town of Zagreb, etc.). It is a total geo-information solution provider.

During the last 8 years, "Gisdata" has gained more than 100 references throughout the GIS community, ranging from large governmental in-

stitutions like the Slovenian Ministry of Environment, to local government organisations (City of Koper) and big utilities such as Croatia and Slovenia Telekom. Besides offering world leading GIS software such as Arc Info and Erdas Imagine, "Gisdata", it provides all kinds of services necessary to establish a working GIS: technical support, education, GIS database design and consulting, application programming and system integration, plus its own SW products.

In its offices in Zagreb (30 people), Rijeka, Ljubljana (6 people), Sarajevo (1 person) and Skopje (3 persons), "Gisdata" has all the necessary state of the art hardware (network servers, workstations, scanner, digitizer, PC's, plotter) and software to serve any client needs. Through its office – "Gisdata Inc.", Redlands, Cal., USA, "Gisdata" maintains contacts with Esri, Erdas and Trimble and sells its products and services on the international market. The biggest asset of "Gisdata" is its staff that is young and dynamic, on a high level of expertise and always in touch with latest developments in the quickly changing world of GIS.

### 3.8 INA – Oil Industry d.d., Informatics Section – Department GIZIS

In the Department GIZIS (Geographic and Land Information Systems) ten people are employed, and they have the latest hardware and software (MicroStation, MGE) of the firm Intergraph at their disposal. They work on the production of maps using digital methods and on the development of geographic and land information systems.

In the period 1991–95 they made digital topographic maps 1:25 000, the digital map of the Republic of Croatia 1:300 000, GIS of the reconstruction of the town Vukovar destroyed in the war in 1991, demographic GIS of the Republic of Croatia and Bosnia and Herzegovina (1).

### 3.9 Lexicographic Institute "Miroslav Krleža"

The fundamental task of the Cartographic Department of the Lexicographic Institute "Miroslav Krleža" is a continuous cartographic support to all encyclopaedia and lexicon publications of the Lexicographical Institute. Furthermore, the Department employing today about 15 employees from time to time makes atlases and geographic and thematic maps of various dimensions. It uses thereby the traditional and computer mapping technology (the programs used are OCAD, Arc View and AutoCAD).

The Cartographic Department of the Lexicographic Institute is staffed by 4 geographers, 2 cartographer-editors and 10 cartographers.

The list of the published works in the period 1992–99 is as follows:

- Geographic Atlas of the Republic of Croatia (together with Školska knjiga, Zagreb), 1992
- Geographic Map of the Republic of Croatia and the Republic of Bosnia and Herzegovina 1:1 000 000, 1992
- Road Map of the Republic of Croatia and the Republic of Bosnia and Herzegovina 1:1 000 000, 1992
- Geographic Atlas of the Republic of Croatia, second edition (in collaboration with Školska knjiga, Zagreb), 1993
- A Concise Atlas of the Republic of Croatia (and the Republic of Bosnia and Hercegovina), 1993
- The Map of the Adriatic Sea with the coast and islands 1:400 000, 1993
- The Road Map of Croatia, Bosnia and Herzegovina, Slovenia 1:500 000, 1995.
- *Atlas of Europe*, 1997. It consists of three thematic parts. These are: macropedia presentation of *Europe* with special attention to the geopolitical issues accompanied by a large number of thematic maps and illustrations. The other part is called *States* and deals individually with 44 European countries. The third atlas part encompasses 46 one page and two page maps in various scales containing a list of names.
- *Croatia* Tourist Guide, 1998 (Croatian, German and English terms). This is the first guide dealing in detail with Croatian tourist regions. It is divided into the *Information part (at the beginning and the end of the book)* and the guide in the narrower sense of the word dealing with individual localities in 4 geographic and historical regions of Croatia. It is rich with illustrations of panoramic photographs, pictures of single tourist facilities and cultural and historical monuments, harbour and marina plans, and also the plans of large cities. More significant monuments are dealt with in the book, and they are unified in the *Tourist Map of Croatia* 1:100 000.
- *Küstenhandbuch Kroatien*, 1998 (published together with the Edition Maritime, Germany, in Croatian, English and German). This is a new edition of the Nautical Guide of the Adriatic Sea. The Guide deals in detail with several Croatian portmaster's offices. This contains the maritime plans of the more important channels and bays, ori-

entation maps, as well as numerous harbour and marina plans. In addition, a map *The Adriatic Sea – Croatian Coast and Island* was made at the scale of 1:400 000.

## 4 Academic Cartography

### 4.1 Geographical Department at the Faculty of Science, University of Zagreb

The Geographical Department (Geografski odsjek Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu) is one of seven departments of natural sciences that make up the Faculty of Science at the University of Zagreb. In the Geographical Department the studies are organised in three teaching subject oriented sectors where cartography is taught in the first year. The titles acquired at the end of studies are Professor of Geography, Professor of Geology and Geography, and Professor of Geography and History. Cartographic material used to be presented earlier in each sector under different, but cartographically recognisable names (Introduction into Cartography, Geographic Knowledge of Maps). The new title of the course of lectures has become unique in the recently changed curriculum – Cartography. In the sectors geography-history and geology-geography, one more hour of lectures has been added (2+1;2+1), and in the sector geography, the situation has remained the same. The fundamental aim of the course "Cartography" is to acquint students with all the elements of the geographic map so that it can be used and correctly applied in teaching others about it. The lectures are therefore accompanied and supplemented by exercises (cartometric procedures, production of relief profiles, simpler projections and similar), as well as by field courses (map orientation, comparison between the contents on map and the nature etc.).

In the Geographical Department many students choose a topic from cartography for their work on their graduation or Master's theses. Namely, the thematic mapping is presented also within the scope of postgraduate studies in the Geographic Department as the course of studies entitled "Thematic Presentation in Spatial Planning and Management".

The elements of thematic mapping adjusted to geographers are presented in the first year of studies in all sectors within the scope of the course of lectures The Elements of Statistics with Geographic Graphic Methods (2+2; 2+2), and for the title, Professor of Geography, from the course of studies, Geographic Information System (0+0; 0+2), has been introduced in the first year.

### 4.2 Institute for Cartography at the Faculty of Geodesy, University of Zagreb

The Institute for Cartography (Zavod za kartografiju Geodetskog fakulteta Sveučilišta u Zagrebu) is one of five institutes of the Faculty of Geodesy at the University of Zagreb. It was founded in 1956, it has 15 employees, among whom six have a permanent obligation in the teaching activity of cartography (23). The Institute has at its disposal the equipment and accessories that enable a comprehensive realisation of even the most complex cartographic tasks.

So far, 250 diploma theses have been presented, along with 14 Master's theses and 8 doctoral theses in the field of cartography.

#### Graduate Studies

According to the new curriculum begun in 1994, the students can, after the first six common terms, choose *Photogrammetry and Cartography* as one of the three subject-oriented fields of the studies.

In the fifth term, all students attend the lectures in General Cartography, and in the sixth term, lectures in Map Projections.

In the subject-oriented field, Photogrammetry and Cartography, the obligatory subject in the seventh term is Digital Mapping I, and in the eighth term, Map Reproduction. In this field, the students are offered the possibility to choose from the following cartographic subjects as well: Geoinformation Systems, Mathematical Cartography, Digital Mapping II, Cartographic Generalisation, Topographic Cartography, Thematic Cartography, Map Usage, Cartographic Symbols and two seminars of Cartography and GIS, and Practical Cartography.

#### Postgraduate Studies

The Postgraduate Scientific Studies of Geodesy at the Faculty of Geodesy, University of Zagreb is organised and performed as the studies intended for acquiring the degree Master of Science, and for acquiring the academic degree Doctor of Science in geodesy. There are also postgraduate professional studies of geodesy. The studies are organised and performed in subject oriented fields:

- Engineering Geodesy
- Photogrammetry and Cartography
- Satellite and Physical Geodesy.

The studies for acquiring the academic degree of Master of Science in geodesy last two years, and the studies for acquiring the academic degree of Doctor of Science in geodesy last three years. The studies for acquiring the academic de-

gree of Doctor of Science for a student who has already got the academic degree of Master of Science last one year.

The teaching obligations consist of elective and facultative subjects. The elective subjects are divided into two groups: general subjects and the subjects of the subject-oriented studies. The group of general subjects is common to all studies. A student can select one of the three subject oriented studies. The elective subjects in the field of *Photogrammetry and Cartography* are: Computer graphics in geodesy, Map facsimiles, Official topographic and the cartographic information system of the Republic of Croatia, Geodetic cartography, Remote sensing, Automation in photogrammetry, Modelling in GIS and Digital relief models.

In the last four years, four Master's theses in the field of cartography have been made (27) (33) (26) (12) and two Doctoral theses (9) (14).

### Workshops

In June and September 1999, as well as in February 2000, the *Institute for Cartography* at the Faculty of Geodesy organised workshops for people working in the practice. Two workshops were held:

1. *Introduction into Digital Mapping and GIS*, intended for those who have had no other opportunity to get acquainted with the new fields of cartographic activity (15 periods of lectures);
2. *Digital Mapping and AutoCAD Map*, intended for the experts who want to deepen their knowledge in digital mapping and to learn the elements of the work with the AutoCAD Map (10 periods of lectures and 20 hours of exercises with computers).

### Equipment

The *Institute for Cartography* provided the following equipment in the period from 1994–99:

- personal computers (11 pcs Pentium and 2 pcs 486DX2)
- laser printer (A4, 3 pcs)
- ink printer (A3 and A4)
- scanner (A4, 2 pcs)
- scanner CalComp 1800 dpi, A0
- plotter TechJet 5536, A0

The students at the Faculty of Geodesy have a computer room for general purposes and five specialized computer rooms with 25 computers altogether.

In the *Computer room for general purposes,* there are eleven computers Pentium 166 MHz, 32 MB installed and connected into the local network and to Internet. More important software is an NT server, AutoCAD Map 2, Microsoft Office, MicroStation.

The *Computer room of the field Photogrammetry and Cartography* has three computers Pentium 100 MHz, 32 MB. Software: GeoMedia, MicroStation, Idrisi.

The *Computer room of the Institute for Cartography* has a computer, Pentium 133 MHz, 32 MB, scanner CalComp S3–1800, A0, 1800 dpi and ink plotters CalComp TechJET 5536, A0 and Epson Stylus Color 1520, A3. Software: OCAD 7, Map Viewer 3.

## Scientific work

### Cartography and Geoinformation Systems

In 1996, work was finished on the scientific project, *Cartography and Geoinformation Systems* (2-12-146), that had been financed by the Ministry of Science and Technology of the Republic of Croatia. The head of the project was Prof. Dr. Nedjeljko Frančula. He had 14 collaborators. Within the framework of the project, the theory of map projections was developed on the basis of the analytical geometry, linear algebra and differential geometry, oriented to the immediate application of computers. The equations of gnomonic perspective conical projections of the sphere were derived and the algorithms for computing and graphic presentation of deformations was made. The modification of Gilbert's projection was carried out, and the formulas for computing deformations were derived, being adequate for computer aided graphic presentation. In the process of trying to find the optimum modern algorithms for computations in connection with the Gauss-Krüger projection, some tasks of essential importance for Croatia became vital: determination of the intersection of the airway corridors with the state border, and the determination and estimation of the accuracy of territorial units area on the basis of digitised borders. It has been proved that by means of these methods, the areas can be determined with great accuracy, even from the map at the scale of 1:1 000 000. The unknown area of the Croatian sea and continental shelf has been determined.

The computer program has been composed for the transformation of co-ordinates between the old co-ordinate systems at the territory of Croatia and the system of Gauss-Krüger projection based on the 14 files of identical points and one file of transformation coefficients. After the

analysis of more than a hundred algorithms for computing geodetic ellipsoidal co-ordinates from spatial rectangular co-ordinates, the best algorithm has been worked out in detail, referring to the distribution of errors. The efficiency of algorithm for computing geodetic latitude from isometric latitude has been analysed. A modified Bowring's algorithm has proven to be the most efficient. The algorithms for copying the rotational ellipsoid onto the sphere and vice versa by applying trigonometric series have been worked out in detail.

For the purpose of distinguishing the objects on maps according to aerial symbols, the present CAD and GIS packages have numerous aerial patterns which, however, are not sufficient. Therefore, new patterns have been generated. When the symbols are generated by applying graphic variables, "tone value", the number of selective degrees is limited. The tests have shown that there are seven degrees of tone value at the most that can be used.

The total number of works accomplished on the project was 244. Along with other works, there are also 2 chapters in books, 103 papers in magazines, 38 papers in the proceedings, 3 Master's thesis and 48 maps. The detailed data about this project can be found in (5) and on Internet at the address:

http://www.mzt.hr/mzt/hrv/znanost/svibor/2/12/146/proj_h.htm

in Croatian, and in English at the address:

http://www.mzt/hr/mzt/hrv/znanost/svibor/2/12/146/proj_e.htm

## Croatian Cartography – Scientific Basis

From 1996, the cartographic research at the Institute for cartography of the Faculty of Geodesy, University of Zagreb, has been carried out within the frame of the scientific project *Croatian Cartography – Scientific Basis* (007001) financed by the Ministry of Sciences and Technology of the Republic of Croatia. The head of the project is Prof. Dr. Nedjeljko Frančula. The general aim of that project is to improve the scientific bases of the cartography development in Croatia. Therefore it is necessary to investigate the contribution of the Croatian cartographers to the development of cartography. One aim of the project is also to supplement the Croatian scientific terminology in the area of cartography and related sciences with modern terms. Another aim is to give one's own contributions in the field of digital mapping: research of local and global distortions, map generalisation and map graphics.

In the selection of the most convenient map projections for the maps of specific areas, the differences in the approach using local and global distortions have not been researched satisfactorily so far. The algorithms installed into the top software for geographic information systems do not offer adequate solutions in removing map deformations caused by ageing of the original. The greatest difficulties in creating the databases of geographic information systems are caused by the unsolved issues of map generalisation. After the establishment of the independent Republic of Croatia, many cartographic activities which used to be under the authority of federal institutions in the former Yugoslavia passed under the authority of the Croatian geodetic and cartographic institutions. It is therefore necessary to improve the scientific elements of the cartography development in Croatia to open the possibilities for these institutions to work successfully on the tasks they have taken over. The theoretical standpoints will be worked out in detail and the algorithms developed for the selection of the most convenient map projection of the Croatian territory. The algorithms intended for removing the map distortions from the data in the vector and raster format will be worked out, as well as the algorithms for the generalisation of line cartographic elements.

Seven collaborators, and one scientific novice participate in the project *Croatian Cartography – Scientific Basis*. The total number of published papers on the project until the summer 1999 was 146. Along with other works, there are 6 chapters in the books (6) (15) (9) (17) (18) (19), 74 papers in magazines, 30 papers in proceedings, two doctoral theses (14) (10) and one Master's thesis (33). Detailed data about the project can be found on Internet at the address

http://www.mzt.hr/mzt/hrv/znanost/projekti/2/007001.htm

In the period 1995-99, the State Geodetic Administration financed the work on three projects: Croatian Cartographers, Geodetic Dictionary and State Border of the Republic of Croatia at Sea.

## Croatian Cartographers

Each nation has an essential need to have systematically worked out and published bibliography about the people who contributed in the several centuries-long historical movements towards the creation of its material and spiritual life. Single nations already have such manuals, and some are in the process of being prepared. The complexity of such work can be seen from

the fact that their creation sometimes takes up to several decades to be completed.

The project, *Croatian Cartographers,* should be a pilot project intended to determine and investigate the problems we might be faced with in arranging the bibliographical material with an aim to initiate a more complex project regarding Croatian geodesists. Under the term, "Croatian cartographer", we understand the Croats or the people of Croatian origin who lived and worked in the field of cartography throughout the world, and the people belonging to other nations or nationalities who were born on the Croatian ground, regardless of where they stayed, and the strangers who lived and worked on Croatian ground contributing to cartography (16)(22)(31).

### Croatian Geodetic Terminology

Wider and wider applications of geodesy in various forms of human activity, as well as the influence of general scientific and technological development on geodesy have considerably widened the extent of the language used today by geodesists. The lack of a dictionary with the terms in use has been felt for a long time in Croatian geodetic activity.

In 1977, a Multilingual Cartographic Dictionary was published by the teachers of the Institute for Cartography at the Faculty of Geodesy. This dictionary is used as the basic origin for the field of cartography. Apart from that, there was a Multilingual Geodetic Dictionary published in the edition SGIGJ, in 1980. This dictionary is, however, not satisfactory, either in a linguistic or terminological sense.

The State Geodetic Administration was therefore proposed to take the project of composing a geodetic dictionary as a pilot project in which the problems of arranging the linguistic material would be defined and investigated, so that one day a more complex project – the multilingual geodetic dictionary – could be initiated.

Several collaborators from outside Croatia are also taking part in the project. The work is slowly coming to its conclusion, although only a few minor contributions have been published so far, e.g. (32)(20).

### Determination of the Croatian State Boundary at the Sea

The project that would result in the list of co-ordinate points on the outer border of the Croatian territorial sea has been suggested to the State Geodetic Administration. This suggestion has been accepted, and the results of the two year long work have been described in the project report.

Each country with a coastline should have reliable navigation maps for all waters that it has a claim upon if it intends to have some use of the coastal area. Furthermore, it is necessary for each seaside country to provide for navigational safety in its waters. The way in which cartography and geometry deal with these problems depends on the applied methods for the description of single parts of the sea and the definitions of the reference line position. For the demarcation methods there are a lot of rules of great importance referring to the ways in which the reference lines can be drawn in the case of complex coastal lines.

In this project a new method for the determination of the line laid out at the given distance from the given line at sea has been suggested. Since a chart is based on the map projection, the nature of the straight line depends on the geometric properties of the projection. Therefore, the research also includes the estimation of the geodesics deviation from the straight line in the Gauss-Krüger projection on the example of the Croatian border in the Adriatic Sea.

The research is completed with the control computation on Bessel's ellipsoid. The analysis of the deviation has shown that their mean value runs up to 3 m, that the mean value of absolute deviation runs up to 10 m, and the mean standard deviation is 12 m (30)(21).

In the last ten years, the members of the Institute for Cartography have also made a number of topographic and thematic maps, among which the following should be pointed out: *Cartographic presentation of the center of Zagreb* at the scale of 1:3 000 intended for the guest of the city and *Operational navigation chart* 1:500 000.

More about the Institute for Cartography at the Faculty of Geodesy, University of Zagreb can be found at the address:

http://pubwww.srce.hr/geo/hrv/kartogr

## 4.3 Institute for Forest Management at the Faculty of Forestry, University of Zagreb

In the last few years, the most related events in the forest cartography in Croatia have been related primarily with the cartography on the academic level, i.e. with pilot projects and research in the field of optimum form and way of presenting forest contents on thematic maps. The research has thereby been oriented mostly towards adopting digital methods and GIS, and toward application of remote sensing in cartography. It has been recorded as especially significant to research the digital relief model pheno-

menon in mapping, the ecological spatial analysis and field classification.

During the last few years, activities in this area have been carried out mostly at the Faculty of Forestry (Institute for Forest Management), the Institute of Forestry (Department for Typology) and in the private firm, "Mirta".

Especially important works are:

- production of orthophoto with inserted forest classification (Institute of Forestry and Geofoto)
- application of Landsat TM images for mapping of forest thematic contents and classification of forest vegetation of Lonjsko polje (Faculty of Forestry)
- application of aerial photographs for mapping of wet biotopes (Crna Mlaka), the biotopes of the City of Zagreb and of land usage in the territory watered by the river-basin at Botoniga (Faculty of Forestry)
- production of forest map models on the basis of topographic maps (1:25 000), colour scanned with the inserted thematic contents in the form of hatching (Mirta)
- production of forest map models on the basis of scanned (black and white) topographic maps 1:25 000 with the thematic contents in the form of transparent colours (Faculty of Forestry)
- production of cartographic two-dimensional and three-dimensional presentation of thematic contents based on digital relief model (Faculty of Forestry)
- production of maps based on interpolation of numeric data of time series (Faculty of Forestry).

### 4.4 Institute for Pedology at the Faculty of Agronomy, University of Zagreb

The employees of the Institute for Pedology at the Faculty of Agronomy in Zagreb (Zavod za pedologiju Agronomskog fakulteta Sveučilišta u Zagrebu) have been making pedological maps on pedogenetic principals in various scales within the scope of their cartographic activity for years. From these maps and data, various specified-purpose maps, e.g. hydropedological maps, irrigation maps, farming conveniences, erosion maps and many others are derived.

For production and printing of these maps, computer methods have been applied since 1995, based on the application of GIS technology in pedological research. The Institute use modern computer equipment (AutoCAD, Arc Info, Arc View, Spatial Analyst, 3D Analyst and digitizer, scanner and plotter of the A0 format).

In 1995, the Soil Map of the County Primorje and Gorski Kotar was made on 23 sheets at the scale of 1:300 000. The map was made in GIS technology with several thematic layers. This is the first digital map on this topic in Croatia. It can be used for planning the maintainable development and the protection and arrangement of the ground on the national and regional level. It can serve as the basis for the water management, for the development of farming and forestry, in spatial planning, environmental protection etc.

At the end of 1997, a very significant project, Geographic and Land Information System of the City of Zagreb and the County of Zagreb, was completed. It was made on the basis of the criteria and standards for the production of maps at the scale of 1:50 000. Hence, the Specified-Purpose Soil Map of the City of Zagreb and the County Zagreb was also made at the scale of 1:50 000. The map shows the ground farming conveniences in this area. It is intended primarily for the development of agriculture in the County of Zagreb, but it is also a very significant basis for physical planning, environmental protection, water management and civil engineering.

During 1998, the Soil Quality Map of the County Primorje and Gorski Kotar was made in digital format and printed in colour. The map shows the quality estimation of the ground. The map is a fundamental document for the production of the physical plan of the County of Primorje and Gorski Kotar, for the purpose of protection and rational management of the ground.

At the beginning of 1999, the project, Production of the European Database and Soil Maps of Europe at the scale 1:1 000 000 – part of the Republic of Croatia – was completed. The information system was made on the basis of criteria and standards for the production of maps at the scale of 1:1 000 000. Hence, the FAO UNESCO soil map of the Republic of Croatia was made in digital format and printed in colour at the scale of 1:1 000 000.

Within the frame of the subject, Pedology and Systematics and Pedological Mapping, the students are getting thoroughly acquainted during their regular studies at the Faculty of Agronomy in Zagreb, and within the scope of the subject Pedological Mapping during the postgraduate studies, with the most recent methods of mapping based on photo interpretative methods. Apart from that, the students are given the possibility to apply their theoretical knowledge during the exercises assisted by their teachers. Previously men-

nected with the Sea, the head, Prof. Dr. Davorin Rudolf, Faculty of Law, Split, http://www.mzt.hr/mzt/hrv/znanost/projekti/5/018002.htm

## 5 Other Activities

### 5.1 Publishing activity

The monograph *Descriptio Croatiae* (24) is the result of thirty years of work of the Academy member, Mirko Marković, through his efforts to gather and process the material. *Descriptio Croatiae* has remained the most integral and the broadest review of the cartography of Croatia and of the Croatian cartography up till the end of the 19th century. It comprises the majority of what was scattered around in numerous articles and studies in different journals which were less accessible to the majority of readers. This work shortens the otherwise tiresome job of searching through so much material looking for the topics, maps and their authors.

There is no magazine being published in Croatia with exclusively cartographic issues. The papers on cartography are usually published in *Geodetski list*. This has been published in Zagreb as a quarterly continuously since 1947. The current *Geodetski list* is the quarterly of the Croatian Geodetic Society. It bears the indication ISSN 0016-710X, and publishes scientific and professional articles, terminological contributions, publications and software review and news. On the occasion of the 17th International Conference and the acceptance of Croatia into the International Cartographic Society, a special issue of *Geodetski list* was published.

In the editions of various publishers, the following books can be entirely or partly included into the field of cartography. They have been published in the last few years (in Croatian):

World Atlas 2000, Mozaik knjiga, Zagreb, 1998.

World Atlas, Edition Zadro, Zagreb, 1998.

Erceg, I.: Josephenian Land Register of the City Rijeka and its narrower surroundings (1785/87), Croatian State Archive and Školska knjiga, Zagreb, 1998.

Frančula, N.: Cartographic Generalisation, script. University of Zagreb, Faculty of Geodesy, Zagreb, 1998.

Frančula, N.: Digital Cartography, 2. revised edition, script, University of Zagreb, Faculty of Geodesy, Zagreb, 1999.

Gelo, J. at al.: Peoples and religious population structure of Croatia: 1880–1991, State Institute for Statistics, Zagreb, 1998.

Hajdarhodžić, H. : Bosnia, Croatia, Hercegovina, AGM, Zagreb, 1996.

Kereković, D. (editor): GIS in Croatia, INA–Oil Industry d.d., Sector of Informatics, Zagreb, 1997.

Klemenčić, M. (editor): Atlas of Europe, Lexicographic Institute "Miroslav Krleža", Zagreb, 1997.

Kozličić, M: Cartographic Monuments of the Croatian Adriatic Sea – selection of maps, plans, views till the end of the 17th century. AGM, Zagreb, 1995.

Krmpotić, Lj.: Reports on the Determination of Croatian Kingdom Borders from 16th to 18th Century, NZ Hrvatski zapisnik, Hannover-Karlobag-Čakovec, 1997.

Lago, L.: Old Maps of the Adriatic Sea. C.A.S.H., Pula, 1996.

Lapaine, M. (ed.): Drawing in Science, Faculty of Geodesy, Zagreb, 1998.

Lapaine, M. and Marjanac, T. (eds): Drawing in Science, Book of Abstracts and Posters, Faculty of Geodesy, Zagreb, 1998.

Lapaine, M., Vučetić, N., Tutić, D.: Cartography and AutoCAD Map, script, University of Zagreb, Faculty of Geodesy, Zagreb, 1999.

Marković, M.: Descriptio Bosnae & Hercegovinae, AGM, Zagreb, 1998.

Muljević, V.: Expedition of the citizen of Varaždin, Ferdinand Konšćak D. I., from Lower California to the river, Colorado, in 1746, Art studio Azinović, Zagreb, 1996.

Pelc, M.: Life and Works of the Engraver from Šibenik, Martin Rota Kolunić, City Library "Juraj Šižgorić", Šibenik, 1997.

Pelc, M.: Natale Bonifacio, Institute for Art History in Zagreb and City Library "Juraj Šižgorić" u Šibeniku, 1997.

Rattkay, I.: Reports from Tarahumara, edited by M. Korade, Artresor Edition, Zagreb.

Sperber, M., Cvetni, V. (eds.): Rainbow Bridge ... Ispod Duge Most ... Regenbogen-Brücke: The Physician and Traveller between two Worlds, Čakovec, 1998.

### 5.2 TV films

- STOKIS Official Topographic and Cartographic Information System of the Republic of Croatia, the bearer of the project – State Geodetic Administration of RH, Zagreb, 1996.
- STOKIS Cartography in Croatia, publisher State Geodetic Administration of RH, Zagreb, 1997.

tioned maps made in the Institute for Pedology are also the part of the teaching material in the above mentioned subjects.

### 4.5 Institute for Pharmaceutical Botany of the Pharmaceutical and Biochemical Faculty, University of Zagreb

Within the scope of the project, *Vegetation Map of Croatia,* the following sheets of vegetation maps have been printed at the scale of 1:100 000 – Pula, Sušak, Žirje, Dugi Island, Osijek, Vinkovci and Slatina.

At the beginning of January 1999, the sheets of vegetation maps of the section Brod, Vukovar and Bačka Palanka were printed at the scale of 1:100 000. However, since the sections Vukovar and Bačka Palanka are border sheets including only a smaller part of the Croatian territory, they were printed on one sheet under the title Vukovar-Bačka Palanka.

During February 1999, the sheet for Sombor, Tuzla and Bijeljina was printed.

All maps made so far within the scope of the project Vegetation maps of Croatia were made and printed on old topographic documentation in polyhedric projection with the initial meridian in Paris.

### 4.6 Scientific projects in Croatia

The data about all scientific projects financed by the Ministry of Science and Technology of the Republic of Croatia (Ministarstvo znanosti i tehnologije Republike Hrvatske) can be found on Internet, at the address:

http://www.mzt.hr/mzt/hrv/znanost/projekti

The following projects among those listed on the Internet belong, entirely or partly, to the field of cartography:

- Vegetation map of Croatia, the head, Prof. Dr. Ivan Šugar, Pharmaceutical and Biochemical Faculty, Zagreb http://www.mzt.hr/mzt/hrv/znanost/projekti/1/006280.htm
- History of the Navigation in the Eastern Adriatic Sea, the head, Prof. Dr. Mithad Kozličić, Faculty of Arts, Zadar, http://www.mzt.hr/mzt/hrv/znanost/projekti/6/070002.htm
- Croatian Cartography – Scientific Bases, the head, Prof. Dr. Nedjeljko Frančula, Faculty of Geodesy, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/2/007001.htm
- Geological Map of the Republic of Croatia 1:50 000, the head, Dr. Marko Šparica, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810101.htm
- Basic Hydrogeological Map, the head, Dr. Božidar Biondić, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810102.htm
- Basic Engineering and Geological Map of the Republic of Croatia, the head, Dr. Karlo Braun, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810103.htm
- Map of Minerals of the Republic of Croatia, the head, Assist. Prof. Dr. Josip Benić, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810104.htm
- Geothermal Map of the Republic of Croatia, the head, Dr. Antun Šimunić, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810105.htm
- Basic Geochemical Map of the Republic of Croatia, the head, Dr. Josip Halamić, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810106.htm
- Structural and Geomorphologic Map of the Republic of Croatia 1:100 000, the head, Dr. Ivan Hečimović, Geological Research Institute, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/01810107. htm
- Description of the Croatian Kingdom Countries, the head, Dr. Mirko Valentić, Croatian Institute for History, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/6/00190101.htm
- Croatian Dialectological Atlas, the head, Dr. Mijo Lončarić, Institute for Croatian Language and Linguistics, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/6/02120103.htm
- Croatian Economy, the head, Assist. Prof. Dr. Milan Nosić, Pedagogical Faculty in Rijeka, http://www.mzt.hr/mzt/hrv/znanost/projekti/6/000905.htm
- Geomorphologic Mapping of the Republic of Croatia, the head, Prof. Dr. Andrija Bognar, Faculty of Science, Zagreb, http://www.mzt.hr/mzt/hrv/znanost/projekti/1/119352.htm
- Borders of the Republic of Croatia in the Adriatic Sea and Economic Relations Con-

- Martin Kolunić Rota, screenplay M. Pelc, producers City Library "J. Šižgorić" and Digital Zoom, Šibenik, 1997.

### 5.3 Exhibitions

In 1992, the historical archives of Split prepared a unique exhibition of cadastral maps with a beautiful catalogue, *Treasures of Croatia from the archives for Istria and Dalmatia*. In 1993, the Museum for Arts and Craft in Zagreb prepared a great exhibition, *The Border of Croatian on the Maps from 12th till 20th century*, which included beautiful reproductions of 88 maps. In autumn 1994, the exhibition, *Older Geographic Maps,* was held in the University Library in Split, accompanied also by a very nice catalogue. A map exhibition was held in the Arts Pavilion in Zagreb at the end of 1994 under the title, *Zagreb on Surveying-Cadastral Maps and in Land Registers*. The representative catalogue has been published containing a lot of valuable articles and reproductions. After 1995 the following exhibitions are worthy of mention:

- *Finland – 500 Years on the Maps of Europe,* Croatian School Museum, Zagreb, 1996.
- *Science among Croats: Natural Sciences and their Application.* Museum and Gallery Centre, Klovićevi dvori, Zagreb, 1996.
- *Plans and Views of Osijek,* The Museum of Slavonia Osijek 1877, Osijek, 1996.
- *Old Maps from the Collection by Z. Gerber,* Karlovac, 1996.
- *Ruđer Bošković, Meeting with a Genius.* Technical Museum in Zagreb, 1997.
- *Cartographers, Geognostic Projections for 21st Century,* The Museum of Modern Art, Art Pavilion and other places in Zagreb, 1997.
- *Exhibition of Computer Maps,* The Museum of Modern Art, Zagreb and Osijek, 1997.
- *Prince Eugène de Savoie – Pictures of the War Raid to Bosnia in 1697,* Art Gallery Vladimir Becić in Slavonski Brod, 1998.
- *Art Presentations of Požega,* City Museum in Požega, 1998.
- *Plans, Drafts and Maps,* Varaždin, 1998.
- *Vukovar and the Neighbouring Settlements on Old Maps,* Osijek, 1998.
- *Kopački rit on Old Maps and Plans,* Osijek, 1998.
- *Drawing in Science,* The Museum Mimara, Zagreb, 1998.
- *GIS Croatia 98,* GIS Association of the Croatian Information Community, Osijek 1998.
- Cadastral Plans in the State Archive in Pazin, exhibition with the Week of Archives and 1800 Years of Land Register in Istria, Pazin, 1999.
- Cartographic Sources for the history of the Triplex Confinium, Colloquium and exhibition at the Croatian State Archives, Zagreb, 1999.
- The Images of Peace – "Croatia Rediviva" and the 1699 Carlowitz Peace Treaty, the exhibition at the Croatian Historical Museum, Zagreb, 18 November 1999 – 15 May 2000.

### 5.4 Section for Cartography of the Croatian Geodetic Society

The first meeting of the Section for Cartography was held on 13th May 1994, at the Faculty of Geodesy, University of Zagreb. Up to the end of 1999, 23 meetings of the Section were held. The reports about the work of the Section are regularly published in *Geodetski list*, the quarterly of the Croatian Geodetic Society.

The Section for Cartography prepared the participation of Croatian cartographers at the 17th International Cartographic Conference and at the 10th General Assembly of ICA in Barcelona in 1995. It also organised the participation of Croatia at the 18th International Cartographic Conference in Stockholm in 1997, and at the 19th International Cartographic Conference and 11th General Assembly in Ottawa 1999.

The Section is arranging the participation of Croatia at the exhibition of children's drawings for the Barbara Petchenik award. The drawing, *Once is Not Enough – Recycle,* by Marinko Cirkvenčić, exhibited in Barcelona, was reproduced on the poster by UNICEF, *Children Draw the World.* The drawing, *Compass Card,* by Anita Matković, was pronounced as one of the winners in Stockholm. At the end of 1995, 1997 and 1999, the ceremonial meetings of the Section were held and used as the occasion at which to hand in the acknowledgements and gifts to the educational institutions participating at the competitions of children's drawings at the conferences in Barcelona, Stockholm and Ottawa (18).

In January 1997, Prof. Dr. Paško Lovrić, the head of the Section, passed away (4). Prof. Dr. Nedjeljko Frančula was elected as the new head.

From 8th June to 27th July 1997, the international exhibition *Cartographers, Geognostic Projections for the 21st Century* was held in Zagreb, sponsored by the Section for Cartography (13).

One of the basic tasks of the Section at the moment of its foundation was the effort to make Croatia a member of the International Cartographic Association – ICA. This was accomplished at the 10th General Assembly of ICA, in Barcelona in 1995. Now it is of great importance to remain a member of ICA and to participate actively in its activities.

Furthermore, it has been planned to organise temporary meetings of the Section in order to pass on the knowledge, experiences and information from cartographic activity to everyone, and especially to Croatian cartographic experts. This is being carried out and should be continued.

Other goals and tasks of the Section for Cartography are as follows:

- To improve information transfer among its members.
- To enlarge the number of members in the Section by bringing in all those who in some way deal with cartography.
- To work on establishing a specialised body that would work on reviewing cartographic products and thus raise the standing of the profession.
- To organise scientific and professional gatherings dealing with cartographic issues.
- To research the possibility of publishing a cartographic magazine.

One can find out more about the activities of the Section for Cartography at the address:

http://public.srce.hr/geo/hrv/hgd/karto

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