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APPLICATIONS OF INFORMATICS IN ENVIRONMENT ENGINEERING AND MEDICINE

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This book consist of the papers describing the applications of informatics in environment and health engineering and protection. Problems presented in the papers concern quality management of the surface waters and the atmosphere, application of the mathematical modeling in environmental engineering, and development of computer systems in health and environmental protection. In several papers results of the research projects financed by the Polish Ministry of Science and Information Society Technologies are presented.

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CHAPTER 3

Informatics and Economy in Environment and Health Protection

THE COMPUTERIZATION OF COMMUNAL WATERWORKS: THE ANALYSIS AND THE PERSPECTIVE[1]

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The article concerns the state of the computerization of Polish communal waterworks firms in the area of GIS systems, monitoring systems, hydraulic models and optimization algorithms appropriated for planning and controlling of the water networks.

Keywords: Computer-aided management processes, GIS systems, monitoring, hydraulic calculations, optimization of water networks.

1. Introduction

More and more workers and managers in waterworks firms and in other municipal enterprises realize the advantages of town's numerical map application for solving the local urban problems. The creation of a local information computer system is an expensive and long lasting process demanding the ruled action of all participants included. Since the application of GIS systems seems to be indispensable in firms exploiting the underground network structures the very often situation in these firms is to digitalize the needed data on the ground of possessed paper geodesic maps using the fact that the municipal and geodesy departments officials keep silent.

That is why in many towns of our country the individual establishments do not wait for municipal or provincial geodesy authorities decisions and began to create the vector pictures of their own installations with an appropriate vector or raster background of the terrain. Many energetic and gas works chose such a way. Following this way many waterworks developed the digitalized geodesic maps of their branches by themselves. The municipal water works in Lublin, Katowice, Zabrze, Tychy, Radom and in Oswiecim are the examples.

Many of the firms did not undertake the task of creating their own numerical maps using GIS systems, because of the high costs of the enterprise and because of

[1] The paper is a result of the research project of the Ministry of Science and Information Society Technologies No. 6T112004C/06302.

the organizational difficulties. These firms wait for what will happen in future or for process of common creation of the municipal numerical map by all interested branches. The cooperation of branches, municipal offices and geodesic departments occurs in many towns in Poland to realize this task faster using the common funds and to safeguard a direct and continuous access to the on-line upgraded numerical maps. The towns Krakow, Bielsko-Biała, Czestochowa, Elblag, Torun, Poznan, Bydgoszcz, Wroclaw and Opole are examples of such cooperation of branches, municipal offices and geodesic departments.

In few cases municipal offices and municipal geodesic departments digitalize themselves maps of theirs regions. These cases are in Kalisz, Wloclawek, Olsztyn, Tarnow, Szczecin, Kielce and Rzeszow. In these towns the individual branches can buy the appropriate map in digital form or in raster form directly in their municipal offices.

2. The present-day state of computerization of chosen water works

The list of domestic waterworks developing numerical map systems of their water networks and presented in the following was made on the ground of interviews.

LP	TOWN/ WATER WORKS	**1. Numerical map – town** **2. Numerical map – waterworks**	NOTICE
1	BIALYSTOK	1. Town: no numerical map 2. Waterworks: a map in implementation with application MapTool of HANSLIK (a branch application of ArcInfo of ESRI)	Investigation lasts for 8 years
2	BIELSKO-BIALA	1. Town: realization of GIS using ArcInfo in cooperation with branches and with HANSLIK 2. Water network: a map in implementation with application MapTool of HANSLIK	Investigation lasts for 9 years
3	BRZEG	1. Town: a map in implementation with application MapTool of HANSLIK 2. Water network: map in implementation with application NetGraf of TechnoProgress	
4	BYDGOSZCZ	1. Town: a map in implementation using Microstation in cooperation with branches 2. Water network: a map in implementation using Microstation	Investigation lasts for 13 years
5	BYTOM	1. Town: realization of GIS using ArcInfo 2. Water network: a map in implementation with application MapTool of HANSLIK	

6	CHRZANOW	1. Town: no numerical map 2. Water network: a map in implementation with application NetGraf of TechnoProgress	
7	CHORZOW/ SWIETO-CHLOWICE	1. Town: no numerical map 2. Water network: a map in implementation with application MapTool of HANSLIK	
8	CZESTO-CHOWA	1. Town: a map in implementation using Microstation 2. Water network: a map in implementation using Microstation in cooperation with INFOKART	
9	DABROWA GORNICZA	1. Town: no numerical map 2. Water network: a map in implementation with application NetGraf of TechnoProgress	
10	ELBLAG	1. Town: a map in implementation using Microstation in cooperation with branches 2. Water network: a map in implementation with application NetGraf of TechnoProgress	
11	ELK	1. Town: a map in implementation using Microstation in cooperation with branches 2. Water network: a map in implementation with application GeoSecma of KORDAB	
12	GDANSK/ SOPOT	1. Town: a map in implementation using Microstation with applications PoverDraft and GeoEdytor of KORDAB 2. Water network: a map in implementation using Microstation with applications Net&GIS and Visit of GEOTECH	Investigation lasts for 8 years
13	GDYNIA/ SAUR-NEPTUN	1. Town: a map in implementation using Microstation 2. Water network: before negotiation procedure (possible application: GeoWater of BENTLEY)	Members of negotiation: HANSLIK, BMT, KORDAB, GLOBEMA
14	GLIWICE	1. Town: a map under MapInfo 2. Water network: a map in implementation using MapInfo	
15	JELENIA GORA/ WODNIK	1. Town: no numerical map 2. Water network: no numerical map	

16	KALISZ	1. Town: a map in implementation on the base of airplane measurements 2. Water network: no numerical map	
17	KATOWICE/ GPWK	1. Town: a map under ArcInfo 2. Water network: a map in implementation using Microstation in cooperation with TechnoProgress	Investigation lasts for 11 years
18	KIELCE	1. Town: a map in implementation under GeoInfo 2. Water network: a map in implementation under Autocad	
19	KRAKÓW	1. Town: a map in implementation under ArcInfo 2. Water network: a map in implementation with application MapTool of HANSLIK	
20	ŁÓDŹ	1. Town: a map in implementation in cooperation with branches but without waterworks 2. Water network: no numerical map	
21	LUBLIN	1. Town: a map in implementation by municipal geodesic department 2. Water network: a map in implementation independently with applications InterCad and CubCad of WellCam Poland	Investigation lasts for 11 years
22	LEGNICA	1. Town: no numerical map 2. Water network: no numerical map	
23	NOWY SACZ	1. Town: a map in implementation in cooperation with branches without waterworks using Geomedia of INTERGRAPH Poland 2. Water network: no numerical map	
24	NOWY TARG	1. Town: no numerical map 2. Water network: no numerical map	
25	OLSZTYN	1. Town: a map in implementation by municipal geodesic department in cooperation with branches 2. Water network: no numerical map	
26	OPOLE	1. Town: a map in implementation in cooperation with SHH Wroclaw 2. Water network: a map in implementation under PARIS of SHH Wroclaw	

27	POZNAŃ	1. Town: a map in implementation using Microstation 2. Water network: a map in implementation with application G/Technology of INTERGRAPH Poland	
28	PRZEMYŚL	1. Town: a map in implementation 2. Water network: a map in implementation with application NetGraf of TechnoProgress	
29	RYBNIK	1. Town: a map under ArcInfo 2. Water network: a map in implementation with application MapTool of HANSLIK	
30	SŁUPSK	1. Town: no numerical map 2. Water network: a map with application NetGraf of TechnoProgress	
31	SANDOMIERZ	1. Town: no numerical map 2. Water network: no numerical map	
32	SZCZECIN	1. Town: a map in implementation 2. Water network: a map in implementation under KOMPAKT-ESRI and with application KOM-NET of KOMPAKT	
33	TARNOBRZEG	1. Town: a map in implementation 2. Water network: no numerical map	
34	TARNOW	1. Town: a map under Microstation exists 2 Water network: no map	
35	TARNOWSKIE GORY	1. Town: a map in implementation under ArcInfo in cooperation with HANSLIK 2. Water network: a map with application MapTool of HANSLIK	
36	TORUN	1. Town: a map in implementation using Microstation in cooperation with HANSLIK 2. Water network: a map with application MapTool of HANSLIK	
37	TYCHY	1. Town: a map with application NetGraf of TechnoProgress 2. Water network: no numerical map	
38	WARSZAWA	1. Town: no numerical map 2. Water network: a map in implementation with an application of MEGABIT	

39	WALBRZYCH	1. Town: a map under ArcInfo 2. Water network: no numerical map	
40	WROCLAW	1. Town: a map under Microstation 2. Water network: a map in implementation under Microstation	
41	ZABRZE	1. Town: a map in implementation under ArcInfo in cooperation with HANSLIK 2. Water network: a map with application NetGraf of TechnoProgress	
42	ZYWIEC	1. Town: no numerical map 2. Water network: a map with application NetGraf of TechnoProgress	

The presented below list of domestic waterworks applying the monitoring systems in water networks has been got as a result of interviews.

LP	TOWN/ WATER WORKS	WATER NETWORK MONITORING	NOTICES
1	BIALYSTOK	A monitoring of most important water network objects exists	
2	BIELSKO-BIALA	A water network monitoring system exists	An application of HANSLIK
3	BRZEG	No monitoring system	
4	BYDGOSZCZ	A monitoring of most important water network objects exists	
5	BYTOM	A monitoring and control system of most important water network objects exists	A cooperation between the monitoring and numerical map under consideration
6	CHRZANOW	No monitoring system	
7	CHORZOW/ SWIETO-CHLOWICE	No monitoring system	
8	CZESTO-CHOWA	No monitoring system	
9	DABROWA GORNICZA	No monitoring system	
10	ELBLAG	A monitoring of new water network objects exists	

11	EŁK	A monitoring of new water network objects exists	
12	GDANSK/ SOPOT	No monitoring system	
13	GDYNIA/SAU R-NEPTUN	An old telemetry system of pumping stations and tanks exists	The data collected in one week cycle
14	GLIWICE	A monitoring of new water network objects exists	Transmission of data using GSM and radio-modems occurs
15	JELENIA GÓRA/ WODNIK	A monitoring of most important water network objects exists	
16	KALISZ	A monitoring of water treatment station and of most important water network objects exists	An application of TechnoProgress
17	KATOWICE/ GPWK	A telemetry system of pumping stations and water treatment station in implementation	
18	KIELCE	A monitoring of water take out stations exists	
19	KRAKOW	A water network monitoring system exists	Under Intouch
20	LODZ	A water network monitoring system exists	
21	LUBLIN	A monitoring and control system of most important water network objects exists	
22	LEGNICA	No monitoring system	
23	NOWY SACZ	A monitoring of new water network objects and pumps control system exist	Under Intouch using GPRS and radio-modems for data transmission
24	NOWY TARG	A water network monitoring system in limited size exists	Plans of system development exist
25	OLSZTYN	A water network monitoring system exists	
26	OPOLE	No monitoring system	
27	POZNAN	A water network monitoring system exists	Under Vizcon
28	PRZEMYSL	A water network monitoring system (19 objects, measurements of P, Q, temperature and rainfall) exists	Under MeraWay
29	RYBNIK	No monitoring system	
30	SLUPSK	No monitoring system	

31	SANDOMIERZ	A monitoring of pump stations exists	
32	SZCZECIN	No monitoring	
33	TARNOBRZEG	No monitoring	
34	TARNOW	A monitoring of tanks and of pump stations exists	
35	TARNOWSKIE GORY	No monitoring system	
36	TORUN	No monitoring system	
37	TYCHY	No monitoring	
38	WARSZAWA	A monitoring of most important water network objects exists	
39	WALBRZYCH	No monitoring system	
40	WROCLAW	A water network monitoring system exists	
41	ZABRZE	A water network monitoring system in implementation	
42	ZYWIEC	A monitoring of most important water network objects exists	

The presented below list of domestic water works firms applying the hydraulic models and sometime optimization algorithms in water networks has been got as a result of interviews.

LP	TOWN/ WATER WORKS	HYDRAULIC MODEL OF WATER NETWORK	NOTICES
1	BIAŁYSTOK	No hydraulic model	
2	BIELSKO-BIAŁA	A hydraulic model applied	An application of HANSLIK
3	BRZEG	No hydraulic model	
4	BYDGOSZCZ	No hydraulic model	
5	BYTOM	No hydraulic model	
6	CHRZANOW	No hydraulic model	
7	CHORZOW/ SWIETO-CHLOWICE	No hydraulic model	
8	CZĘSTO-CHOWA	No hydraulic model	A plan of model application exists

9	DABROWA GORNICZA	No hydraulic model	
10	ELBLAG	A hydraulic model applied	Model NetSimula of TechnoProgress
11	ELK	A hydraulic model applied	Models EPANET and MikeNet
12	GDANSK/ SOPOT	A hydraulic model applied	Model SIMIC from France; model calibration occurs
13	GDYNIA/SAUR-NEPTUN	No hydraulic model (a plan of buying model Select)	Model Select cooperates with application GeoWater of BENTLEY
14	GLIWICE	No hydraulic model	
15	JELENIA GORA/ WODNIK	No hydraulic model	
16	KALISZ	No hydraulic model	
17	KATOWICE/ GPWK	Hydraulic models applied	Models EPANET and ODULA
18	KIELCE	No hydraulic model	
19	KRAKOW	A hydraulic model in implementation	
20	ŁODZ	No hydraulic model	
21	LUBLIN	A hydraulic model applied	Model EPANET
22	LEGNICA	No hydraulic model	
23	NOWY SĄCZ	No hydraulic model	
24	NOWY TARG	No hydraulic model	
25	OLSZTYN	No hydraulic model	
26	OPOLE	No hydraulic model	
27	POZNAN	No hydraulic model	
28	PRZEMYSL	No hydraulic model	
29	RYBNIK	No hydraulic model	
30	SLUPSK	No hydraulic model	
31	SANDOMIERZ	No hydraulic model	
32	SZCZECIN	No hydraulic model	
33	TARNOBRZEG	No hydraulic model	
34	TARNOW	A hydraulic model applied	Model EPANET

35	TARNOWSKIE GORY	No hydraulic model	
36	TORUN	No hydraulic model	
37	TYCHY	No hydraulic model	
38	WARSZAWA	A hydraulic model applied	Model PICCOLO
39	WALBRZYCH	No hydraulic model	A plan of model application exixsts
40	WROCLAW	A hydraulic model applied	An author's model of an employee of the firm applied
41	ZABRZE	No hydraulic model	
42	ZYWIEC	No hydraulic model	

3. The analysis of current state of water networks computerization

The analysis of collected information shows the best situation in the case of numerical maps used in water networks. To be true the numerical maps are still worked out in most of Polish waterworks but about 70 % of them are expected to have numerical maps of their branch in foreseeable future. The situation is quite different than the situation few years ago what means that numerical maps of water networks become the ordinary tool in waterworks. But still 30 % among the 42 chosen representative domestic waterworks do not have and do not plan to use the numerical maps what means that the operational management of water network in these firms is done manually. The main reason of such a state is a cost and time-consuming process of GIS systems created.

More and more of municipal geodesic offices try to gain funds for creating the digital stores of the town's geodesic maps in connection with records of land pieces and with records of ground installations. Thanks of that the branch firms and also the waterworks can buy digitalized geodesic maps in their municipal offices and then they can adapt them for their branch needs. Such a situation takes place in about 70 % of investigated towns.

Sometimes municipal geodesic departments create a map in agreement with communal branches to achieve a higher efficiency of GIS creating process and to reduce the costs. Such an agreement is connected with cooperation of all branches and their obligation to go to any expenses, so there are not many towns accepting this challenge.

In 30 % of cases the geodesic offices do not undertake the task of digitalizing the municipal maps mainly because of lack of money and then the branch firms try to do it themselves or they do nothing.

The most often used graphical tool for digitalizing the municipal maps is Microstation system of American firm BENTLEY and ArcInfo system of also American firm ESRI. Sometimes the other systems are used as Geomedia of American firm INTEGRAPH or NetGraf of TechnoProgress firm from Krakow.

Many different programs are used in case of creating branch numerical maps for water networks. The most often used systems are ArcInfo and Microstation but also often NetGraf and another applications as Geomedia and G/Technology of INTEGRAPH, GeoWater of BENTLEY, GeoSecma of Swedish firm KORDAB as well as InterCad of Taiwan firm WellCam or KOM-NET of firm KOMPAKT from Warsaw are used.

The ArcInfo system and its branch application MapTool of firm HANSLIK from Katowice are the most applied systems for generation the numerical maps for towns and also for the waterworks branch, especially in Silesia. Many applications of numerical maps for waterworks have been developed by the firm TechnoProgress from Krakow using its software NetGraf. But at this time this firm is supplanted by applications of other firms having the idea of close cooperation between the waterwork applications and the municipal maps implemented and up graded in municipal geodesic offices. Apart from that there are few applications of some firms from abroad as INTEGRAPH, BENTLEY, WellCam or KORDAB, and from Poland as SHH from Wroclaw, GEOTECH from Bydgoszcz and MEGABIT, KOMPAKT and INFOKART from Warszawa, which are used in Polish waterworks.

The analysis of state of computerization of communal waterworks in area of monitoring systems shows that this situation is worse than in case of numerical maps. About 40 % of investigated waterworks do not have and do not plan the introducing of monitoring of water networks and only 19 % of the waterworks have almost full monitoring systems. The rest of 40 % of the waterworks makes the monitoring of only important parts of the networks, such as tanks, pumping stations and water take out stations, what does not make a right picture of the quality of work of a water network. The cooperation between monitoring systems and numerical maps was planned only in three investigated waterworks and in other waterworks these systems if they are they work independently.

Another problem is that there is not an idea of standardization of programs for collecting and visualization of measurements data and of methods for data transmission. As a result in Polish waterworks many different visualization programs are used like Vizcon, Procon, Intouch or MeraWay as well as different transmission methods from classical telemetry to GPS or GPRS and to radio transmission are there applied.

Absolutely worst situation takes place in area of application of hydraulic models of water networks. Only 24 % of waterworks investigated use such models and mostly it is model EPANET accessible in internet. In many of waterworks there are no plans concerning hydraulic calculations. Mostly the used programs do not

cooperate with numerical map systems and monitoring systems even if they are used in a firm. In the case of the branch software offered by the computer firms like HANSLIK, TechnoProgress, BENTLEY, GLOBEMA, INTERGRAPH, KORDAB or SHH, they present their branch applications for creating the numerical maps often with options for water network modeling, but there are no possibility of collaboration between these programs in form of an integrated information system. In these applications there are not any water network optimization modules based on hydraulic calculations or monitoring systems and there is neither possibility of observing and elimination of water losses in water networks.

4. Conclusions

There are few factors which make the every day operation of water networks easier and better. The most important is the competent introduction of a GIS system developed in the waterworks into ordinary activity of the firm and especially into departments which could take an advantage from using the water network numerical map. The main difficulties in common using of the water network maps are the cost of the whole enterprise and many organization problems. But we can say that the consciousness of large usefulness of numerical maps does appear more and more in Polish waterworks.

In the case of monitoring systems the main impediment in application of them in large is the cost of devices, particularly the cost of water flow meters and the lack of algorithms for choosing the right measurement points minimizing the number of devices and optimizing the quality of collected information.

The belief about the usefulness of hydraulic models of water networks is still low and it is the reason that the number of such the applications is insignificant.

A large disadvantage of tasks realized in the waterworks and concerning their computerization is treatment of the programs introduced there like separated units while they shall cooperate together as an uniform information system. Such the situation will occur when hydraulic model of water networks will be used in a larger scale for only the calibration of a hydraulic model forces its connection with a monitoring system and with a numerical map. A large usefulness of hydraulic models for the management and operation of water networks will be noticed when these models will be widely used to solve optimization tasks in waterworks what does not occur now. A lack of appropriate optimization algorithms in the operational practice of the waterworks is caused by the lack of such the algorithms in the computer firms applying their software in waterworks and otherwise by lacking a right cooperation procedures between the waterworks enterprises and the research institutes in Poland. Until this situation will not improve then the state of computerization of the Polish waterworks will not change and they will try to solve their informatics tasks in such a way as till now, i.e. mostly in an accidental way and

independently from other branches and from each other and only due to their very differentiated and often very limited financial possibilities.

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APPLICATIONS OF INFORMATICS IN ENVIRONMENT ENGINEERING AND MEDICINE

The purpose of the present publication is to popularize applications of informatics in environment and health engineering and protection. Runned papers are thematically chosen from the works presented during the conference *Multiaccessible Computer Systems* (*Komputerowe Systemy Wielodostępne*) that has been organized by the Systems Research Institute and University of Technology and Agriculture of Bydgoszcz for several years in Ciechocinek. Problems described in the papers concern quality management of the surface waters and the atmosphere, application of the mathematical modelling in environmental engineering, and development of computer systems in health and environmental protection. In several papers results of the research projects financed by the Polish Ministry of Science and Information Society Technologies are presented.

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