CIVIL AND ENVIRONMENTAL ENGINEERING REPORTS

No.7 2011

METEOROLOGICAL DATA IN THE SIMULATION OF COMBINED SYSTEM WORK CONDITIONS

Jerzy WIRA[1], Ireneusz NOWOGOŃSKI[2*], Ewa OGIOŁDA[2]
[1]Faculty of Civil Engineering and Architecture
West Pomeranian University of Technology
Al. Piastów 50, 70-311 Szczecin,
[2]Institute of Environmental Engineering
University of Zielona Góra
Szafrana st 15, 65-516 Zielona Góra, Poland

In the paper results of combined system work simulation basing on rainfall data were shown. Rainfall height values were read for three time interval precisions: 10, 30 and 60 minutes. The last event corresponds with precision gained when using pluviographical specification. Simulation was realised for a calibrated catchment in Głogów. Obtained results point at possibility of significant differences gained when the simulation process is realized with data read directly from pluviographical recording in comparison with pluviographical specification usage. Reading with too low precision decreasing rainfall intensity differences in time could be also a reason why similarity of simulation results and direct reading is low. Such data application in calibration process could lead to parameters which could be rejected in verification of calibrated model.

Keywords: combined sewage system, rainfall-runoff phenomena, simulation

1. INTRODUCTION

In design practice and science work it is import ant to have an access to reliable data making possible analysis of conditions in combined systems. For rainfall intensity it is necessary to build measuring system adjusted to analysed catchment area. For meteorological data useful should be resources of Institute of Meteorology and Water Management, but there occur following problems:

– not enough developed measurement points system,
– high cost of access to archival data,

[*] Corresponding author. E-mail: i.nowogonski@iis.uz.zgora.pl

– problems with getting data more precise than specification of rainfall in one-hour intervals.

Usefulness of pluviographical registration including height and duration of rainfall in particular hours for methods applied in calibration of simulation models is limited only to initial calibration. Presented results show differences noticed for application of different reading precision of rainfall data.

2. MODEL CALIBRATION

Calibration of model basing on simplified data makes possible to obtain results acceptable considering maximum momentary flow. When precise occurrence run is necessary to simulate cooperation of sewer network with storage or treatment devices gained precision could be not sufficient. Model calibration of catchment in Głogów based on EpaSWMM could be an example (Wira, Nowogoński 2006). There are shown in Fig. 1 examples of depth variability in measuring point of conduit – darker line show results of simulation, lighter one – results of measurement. The difference for maximum depth is even up to twenty percent, what could be explained by measuring errors and not taking into consideration spatial rainfall variability. Shape of an obtained curve is certainly directly connected with average values of rainfall intensity.

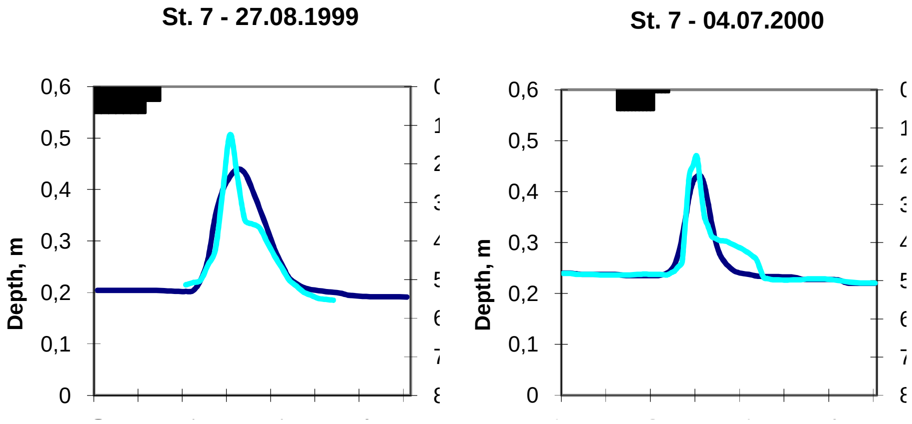


Fig. 1. Comparison of measurement and calculated by SWMM model results (Wira, Nowogoński 2006)

As the result we get idealized curve of depth variability, what in extreme cases could has an effect on accuracy of suggested solution, exploited in unfavourable conditions. In the next part of this paper the results of theoretical consideration based on measurement data obtained in Zielona Góra are presented.

3. NUMERICAL SIMULATION

Numerical simulation includes analysis of flow from catchment of 60,9 ha total and impervious 29,84 ha area localized in central part of Głogów (Fig. 2). Analyzed catchment isn’t equipped with storage and treatment devices or flow dividers. The city is located in Dolnośląskie Province 60 km away from Zielona Góra. Calculations were realized with EpaSWMM 5.0 (Rossman 2005) using calibration parameters obtained by Wira and Nowogoński based on research project carried out in Głogów from 1998 to 2000 (Wira, Nowogoński 2006). Graphical representation of analysed combined network is shown in Fig. 3.

Fig. 2. Localisation of analysed catchment in Głogów

Four events observed in meteorological station in Zielona Góra were chosen – their rainfall ranges from 13,2 to 50,8 mm and rainfall intensity was from 8,5 to 33,9 mm/h. For each precipitation reading time interval precisions were 10, 30 and 60 minutes. The last event correspond with precision gained when using pluviographical specification. After counting rainfall intensity on flow rate values in particular time intervals it was possible to use obtained results in simulate calculations.

Obtained results of rainfall intensity and flow rate variability in time for 3 chosen recording precision were shown in Fig. 4 – 11.

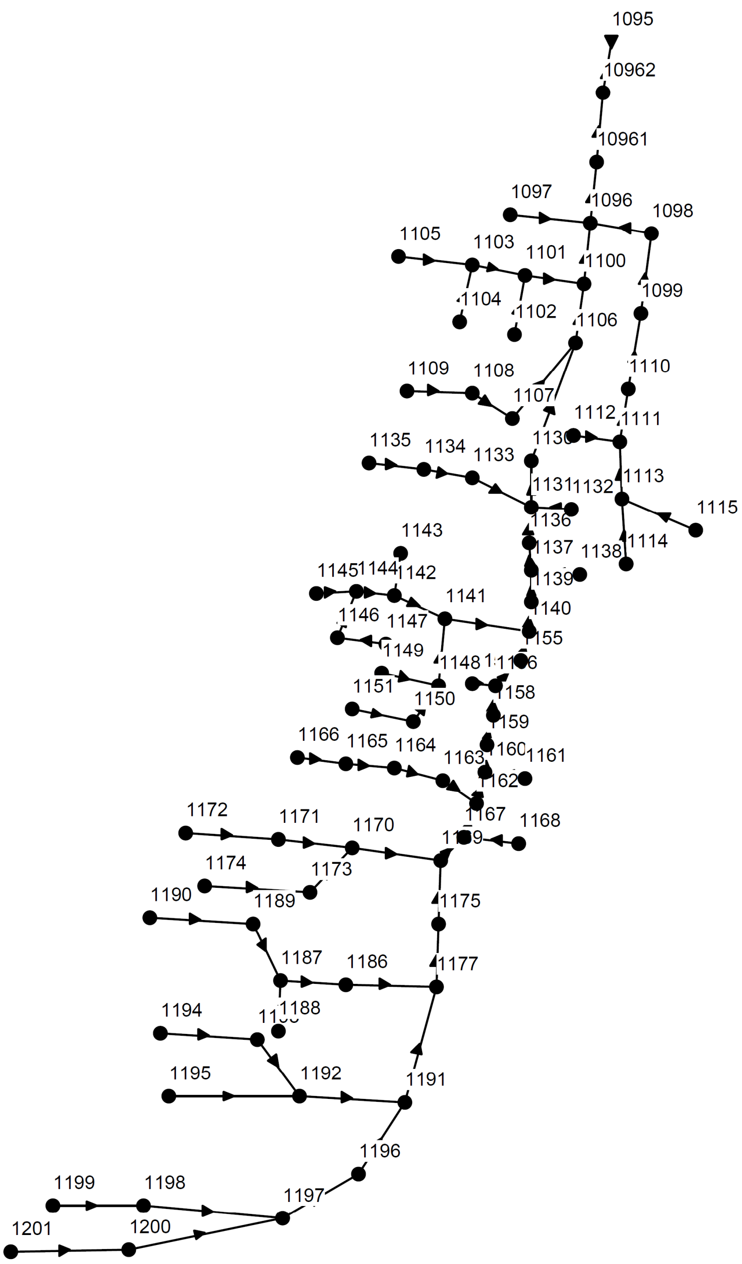
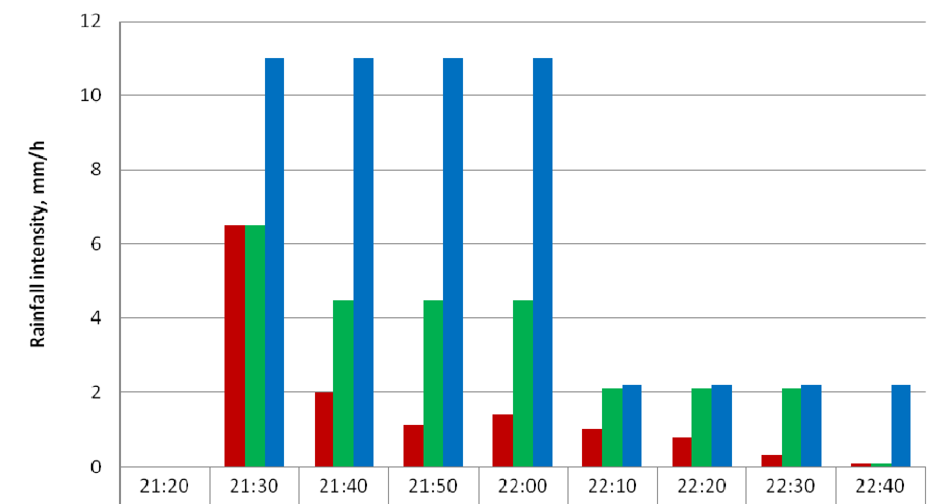


Fig. 3. Graphical representation of analysed combined Network



	21:20	21:30	21:40	21:50	22:00	22:10	22:20	22:30	22:40
10 min	0	6,5	2	1,1	1,4	1	0,8	0,3	0,1
30 min	0	6,5	4,5	4,5	4,5	2,1	2,1	2,1	0,1
60 min	0	11	11	11	11	2,2	2,2	2,2	2,2

Fig. 4. Characteristic of rainfall - 1983.07.18

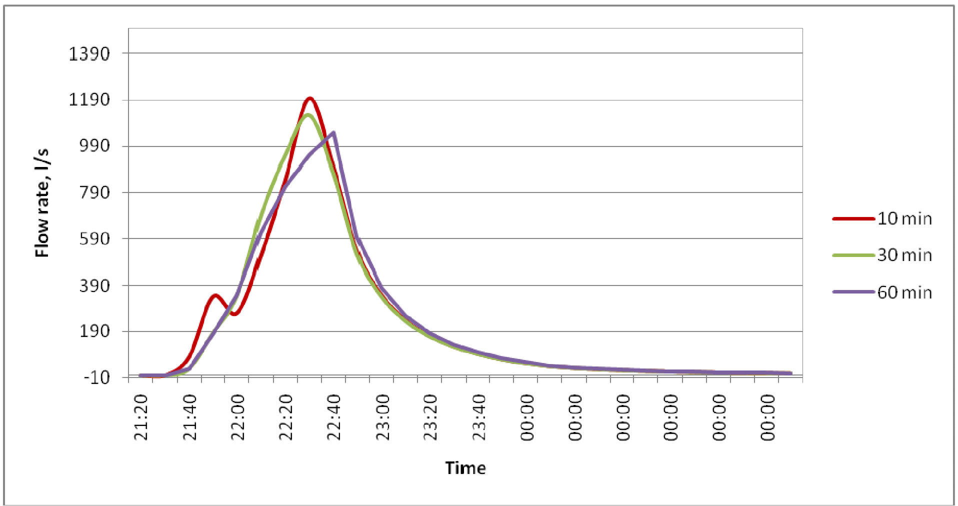
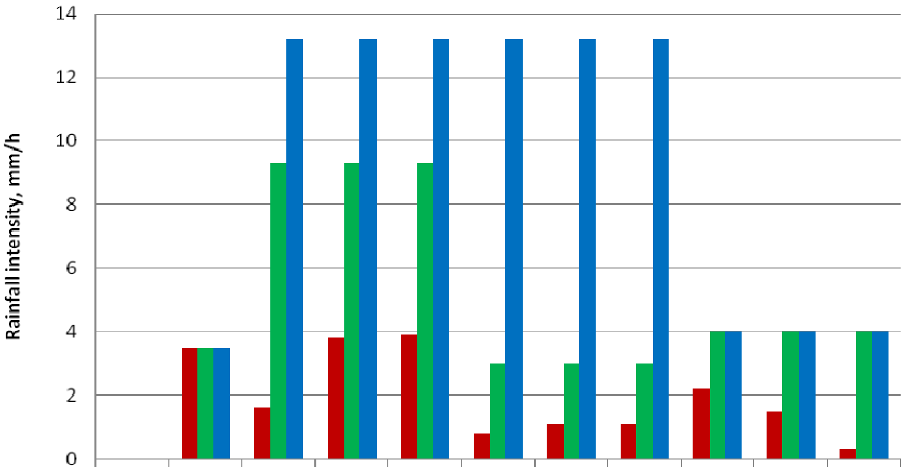


Fig. 5. Flow rate variability - 1983.07.18



	21:50	22:00	22:10	22:20	22:30	22:40	22:50	23:00	23:10	23:20	23:30
10 min	0	3,5	1,6	3,8	3,9	0,8	1,1	1,1	2,2	1,5	0,3
30 min	0	3,5	9,3	9,3	9,3	3	3	3	4	4	4
60 min	0	3,5	13,2	13,2	13,2	13,2	13,2	13,2	4	4	4

Fig. 6. Characteristic of rainfall - 1983.05.23

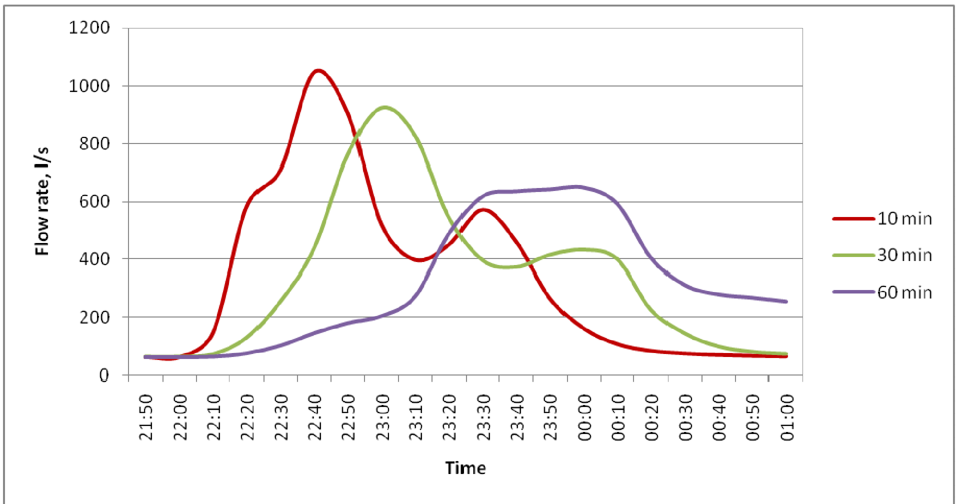
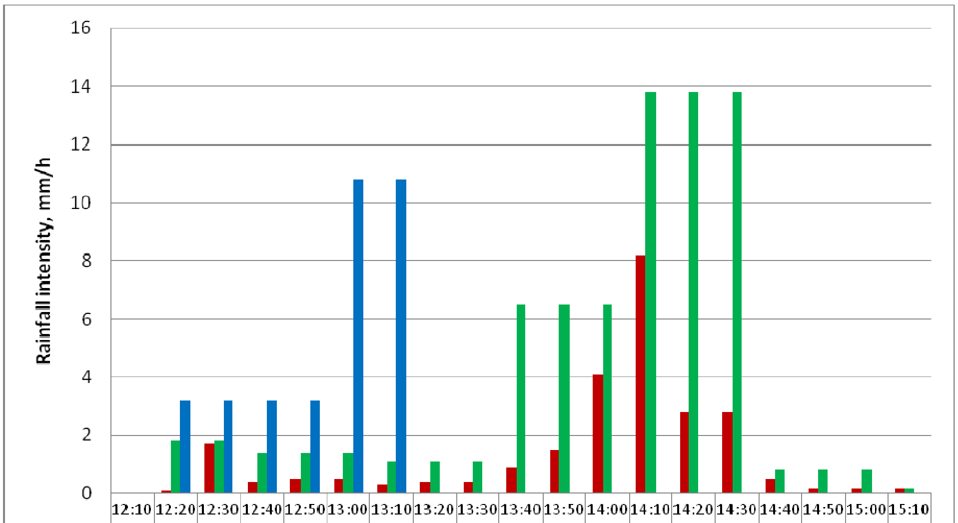


Fig. 7. Flow rate variability - 1983.05.23



	12:10	12:20	12:30	12:40	12:50	13:00	13:10	13:20	13:30	13:40	13:50	14:00	14:10	14:20	14:30	14:40	14:50	15:00	15:10
10 min	0	0,1	1,7	0,4	0,5	0,5	0,3	0,4	0,4	0,9	1,5	4,1	8,2	2,8	2,8	0,5	0,15	0,15	0,15
30 min	0	1,8	1,8	1,4	1,4	1,4	1,1	1,1	1,1	6,5	6,5	6,5	13,8	13,8	13,8	0,8	0,8	0,8	0,15
60 min	0	3,2	3,2	3,2	3,2	10,8	10,8	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 8. Characteristic of rainfall - 1984.07.15

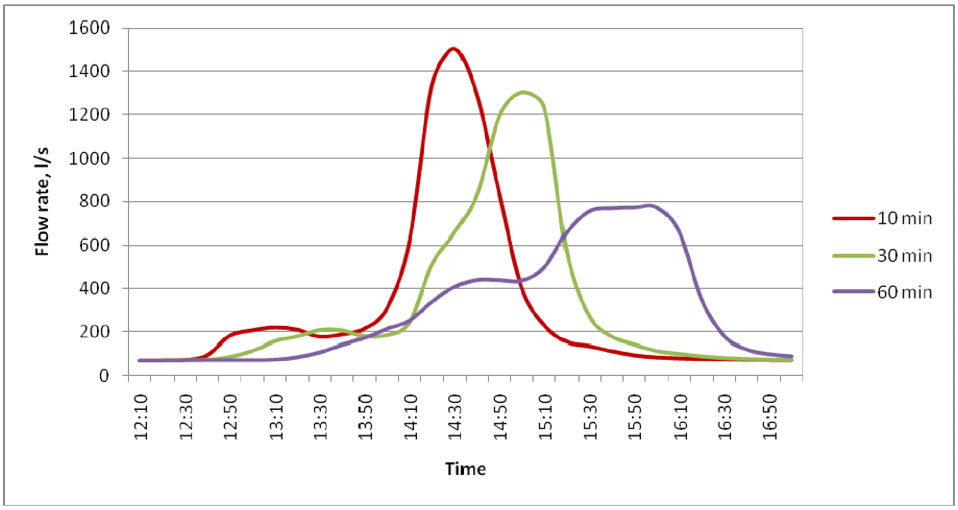
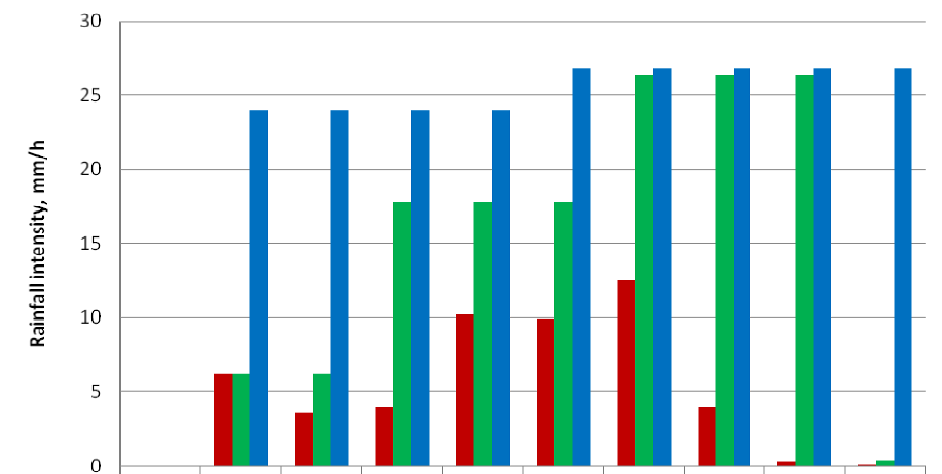


Fig. 9. Flow rate variability - 1984.07.15



	23:20	23:30	23:40	23:50	00:00	00:10	00:20	00:30	00:40	00:50
10 min	0	6,2	3,6	4	10,2	9,9	12,5	4	0,3	0,1
30 min	0	6,2	6,2	17,8	17,8	17,8	26,4	26,4	26,4	0,4
60 min	0	24	24	24	24	26,8	26,8	26,8	26,8	26,8

Fig. 10. Characteristic of rainfall - 1984.08.11

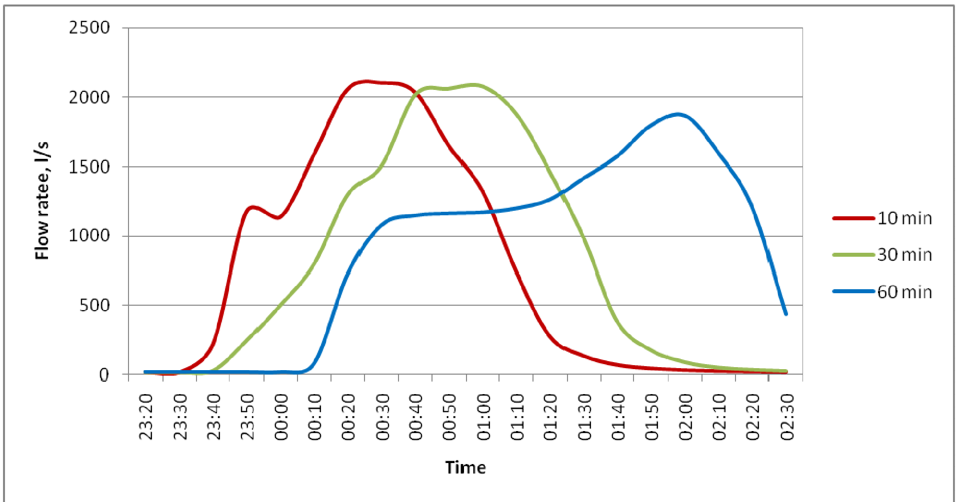


Fig. 11. Flow rate variability - 1984.08.11

4. RESULTS ANALYSIS

In the most cases of analyzed events differences of flow rate variability are visible in the graphic part of paper. Errors of maximum flow rate evaluation were estimated to illustrate found differences in numbers. As a comparative level variant of the best rainfall data recording precision were taken.

Table 1. Specification of maximum flow rates

Event date	Maximum flow rate [lps]			Maximum flow rate error [%]	
	10 min	30 min	60 min	30 min	60 min
1983.05.23	1049,71	925,41	648,22	11,84	38,25
1983.07.18	1140,81	619,71	588,87	45,68	48,38
1984.07.15	1506,92	1303,19	773,89	13,52	48,64
1984.08.11	2106,45	2076,62	1868,46	1,42	11,30

The obtained results point at a possibility of significant differences gained when simulation process is realized with data read directly from pluviographical recording in comparison with pluviographical specification usage. Reading with too low precision decreasing rainfall intensity differences in time could be also a reason why similarity of simulation results and direct reading is low. Such data application in calibration process could lead to parameters which could be rejected in verification of calibrated model. Noticed errors up to 49% could cause that model of low usefulness in system exploitation will be implemented.

5. CONCLUSIONS

The results of outfall simulation assuming different rain parameters data precision show a necessity of getting detailed meteorological data basing on gaining monitoring net of the company exploiting drainage systems. Besides discussed problems with precision of input data effect of time-space variability of rainfall on calibration model efficiency (Nowogoński 2008). Unfavourable parameters accumulation in connection with obvious measuring errors could be fundamental reason of low conformability simulation results with measured values. So the only solution is to institute monitoring both - measurements of flow in chosen pipes and rainfall to state range of occurrence, direction and velocity of translocation in relation to catchment.

The next problem is usage of pluviographical data base. Easier access for science institutes to information and resources of Institute of Meteorology and Water Management could help to work out principles to design combined sewers systems localized near meteorological stations.

REFERENCES

1. Rossman L. A.: *Storm Water Management Model. User's Manual. Version 5*, Cincinnati, US EPA 2005.
2. Nowogoński I, Wira J.: *Kalibracja hydrauliczna modelu SWMM przy wykorzystaniu danych z badań na terenie miasta Głogowa*, Instal, 264, 9 (2006) 81-84.
3. Nowogoński I.: *Odpływ ze zlewni deszczowej przy uwzględnieniu czasoprzestrzennej zmienności opadu*, Oczyszczanie ścieków i przeróbka osadów ściekowych – tom 2, Zielona Góra, Uniwersytet Zielonogórski 2008, 15-24.

DANE METEOROLOGICZNE W SYMULACJI WARUNKÓW PRACY OGÓLNOSPŁAWNEJ SIECI KANALIZACYJNEJ

S t r e s z c z e n i e

W pracy przedstawiono rezultaty sumulacji pracy ogólnospławnej sieci kanalizacyjnej przeprowadzonych w oparciu o dane opadów. Wysokości opadów zostały odczytane z taśm pluwiograficznych z dokładnością co 10, 30 i 60 minut. Ostatni przypadek odpowiada dokładności zestawień pluwiograficznych. Symulacja prowadzona była dla wstępnie skalibrowanej zlewni na terenie Głogowa. Dane do kalibracji uzyskano w ramach prac badawczych prowadzonych w latach 1998-2000. Uzyskane rezultaty potwierdzają możliwość wystąpienia znaczących różnic uzyskiwanych przy użyciu w procesie symulacji danych pochodzących bezpośrednio z taśm pluwiograficznych lub z urządzeń elektronicznych w porównaniu z zestawieniami pluwiograficznymi. Zastosowanie takich danych w procesie kalibracji modelu symulacyjnego z kolei może doprowadzić do uzyskania parametrów kalibracji, które mogą zostać odrzucone w procesie weryfikacji skalibrowanego modelu. Zaobserwowane błędy sięgające 49% mogą doprowadzić do wdrożenia modelu mało przydatnego w eksploatacji systemu.