Journal of the Korean Society of
Agricultural Engineers, Vol. 42, 24~30
June 2000

Development of a System for Regular Evaluation of Streamflow Data (KOwaco's Regular Streamflow Appraising System)

Noh, Jae Kyoung*

* *Water Resources Research Institute, Korea Water Resources Corporation*

Abstract □ A system for evaluating streamflow data (KORSAS) was developed, and is operated using PC based Windows to help the hydrological observation practitioner's working in Korea Water Resources Corporation (KOWACO). This system has modules including; DB access and data management, flow measurement arranging, H-Q relation deriving, area rainfall calculating, flow calculating, and flow evaluating modules. Evaluation of observed streamflow is accomplished through the following processes. First, hourly streamflow data is calculated from water level data stored in a DB server by applying the rating relationship between water level and flow rates derived from the past flow measurements. Second, hourly areal rainfall data is calculated from point data stored in the DB server by applying Thiessen networks. Third, hydrographs are displayed on a daily, weekly, monthly, or seasonal duration basis, and are compared to hydrographs of reservoir inflow, hydrographs at water level observation stations and hydrographs derived from simulated results using models.

Keywords □ streamflow, reliabilty, evaluation, system

I. Introduction

To understand streamflow is necessary in water resources planning and operation. However, data reliability of the various streamflow data produced in Korean streams is of varying quality and significance to water resources projects. At present, water levels in streams and rainfall amounts are observed on a real-time base and stored in a database(DB) through a telemetering system. Flow rates at observation sites are calculated by ready-made rating curves between water levels and flow rates.

The reasons for unreliable streamflow data are as follows; disagreement of observed water levels between gauges and streams, inaccurate results of measured flow rates, complex relationships between water levels and flow rates in streams, transformation of stream cross sections, change in water surface profiles due to continuous sedimentation and stream bed scouring, etc.. Data managers have some difficulties in considering the above causes of errors and in filtering the above errors, especially in the time elapsed data. Therefore, streamflow data containing errors has to be corrected as data is observed, and the causes of errors should be recorded and reflected for future data management.

On the other hand, reservoir inflow can be calculated by using the changes of reservoir water levels and water uses and releases from the result of reservoir operation. The streamflow data within watersheds are compared with the reservoir inflow, thus the reliability of streamflow data is evaluated. The reliability of streamflow data is enhanced through prompt evaluation and management of calculated flow data as soon as water levels are observed. The evaluation of streamflow rates is performed on a daily, weekly, monthly and a seasonal basis. By using this procedure, the streamflow data, that is, the gauge station is continuously checked and maintained without problems.

So, the evaluation periods of streamflow are short term (event based) and long term (continuous based). The evaluation can be performed by comparing the streamflow data with the reservoir inflow or the simulated result from rainfall-runoff models.

The purpose of this study is to develop a computer system (KORSAS) for the data manager to validate the streamflow data by using the reservoir inflow data and simulated runoff data from rainfall-runoff models.

II. Design of System

The system was designed to comprise of modules including; DB access and data management, flow measurement management, H-Q relation derivation, area rainfall calculation, flow calculation, and flow evaluation. KORSAS was configured with the above modules and is related with other hydrological systems as shown Fig. 1. The real time hydrological data management DB and meteorologic information DB in KOWACO are now maintained using the Oracle Database management system, and are accessed through the local intranet.

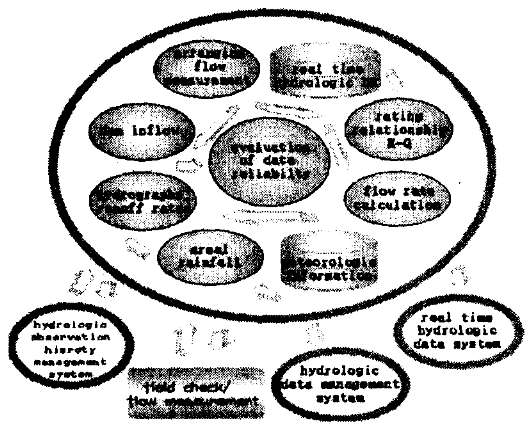

Fig. 1. System configuration of KORSAS

III. Construction of System

The system was constructed for operation on PC based Windows and was programmed using Visual Basic 6 language. Menus, command buttons, and labels in KORSAS are written in the Korean language to provide Korean hydrological engineers with easy, user-friendly handling. Examples of the system operation are

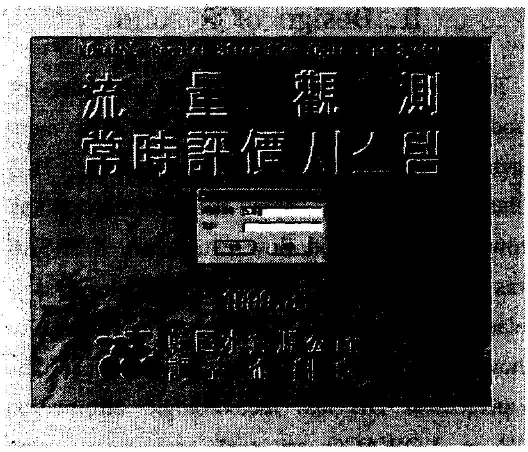

Fig. 2. Initial screen of KORSAS

shown in Fig. 2~Fig. 9.

Fig. 2 is the initial log-in screen and Fig. 3 is the main screen to access various modules.

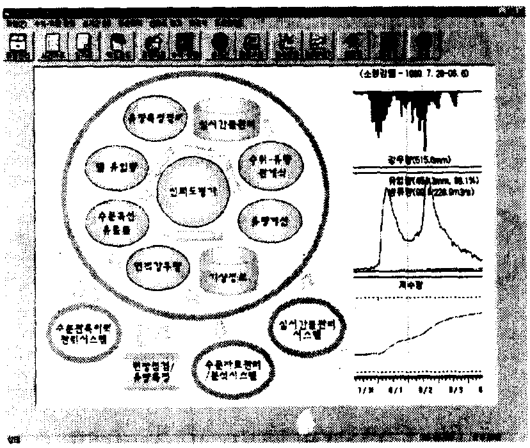

Fig. 3. Main screen of KORSAS

Fig. 4 is an example of point rainfall data from the Oracle DB. Fig. 5 shows water levels from stream gauge stations and Fig. 6 shows areal rainfall from Thiessen networks and its water level. Fig. 7 is a rating curve between water levels and flow rates. Fig. 8 is an example hydrograph, in which streamflow data

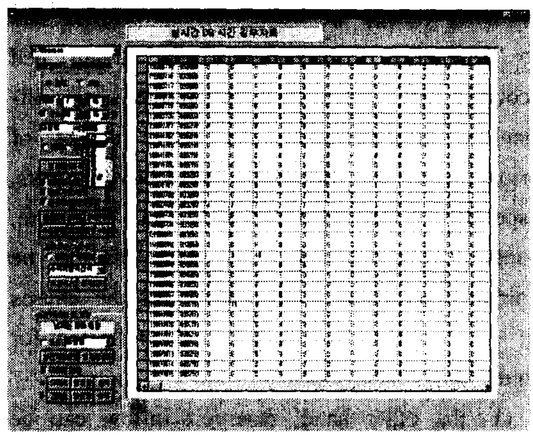

Fig. 4. Hourly real time rainfalls

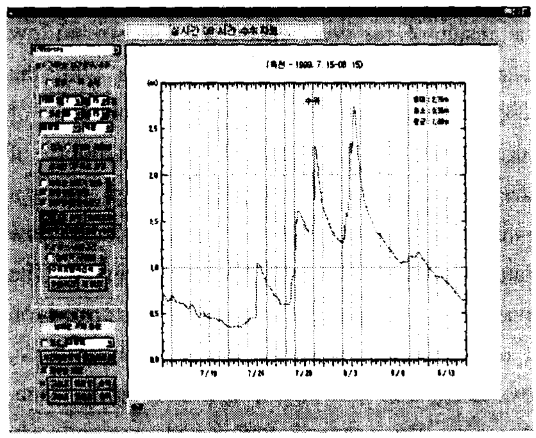

Fig. 5. Hourly real time water levels

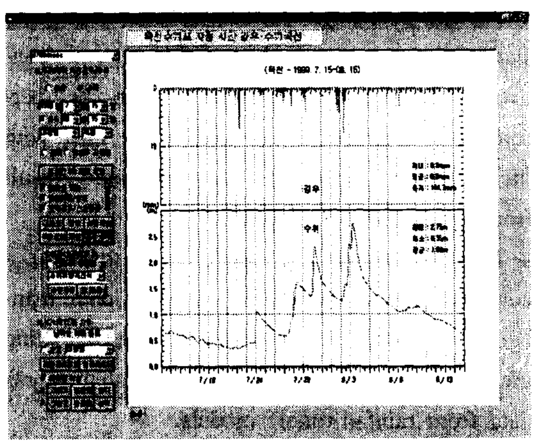

Fig. 6. Hourly areal rainfalls and water levels

can be evaluated. Fig. 9 is an example of hourly reservoir operation results.

IV. Application of System

KORSAS was applied to Daechung Dam watershed and the results are shown in Fig. 10~Fig. 15. Fig. 10 is an example showing the measured streamflow data and its flow rate. Fig. 11 shows an example with flow rates and hydrographs using the rating curve equation. Fig. 12 shows an example of flow

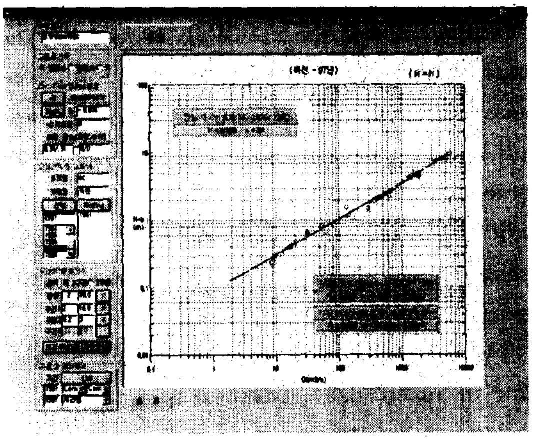

Fig. 7. Deriving relationship between H and Q

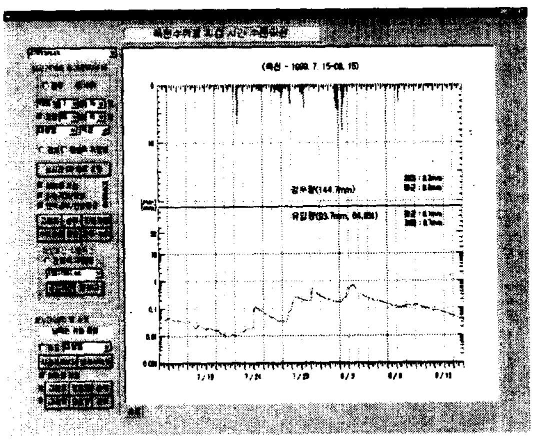

Fig. 8. Hourly hydrographs

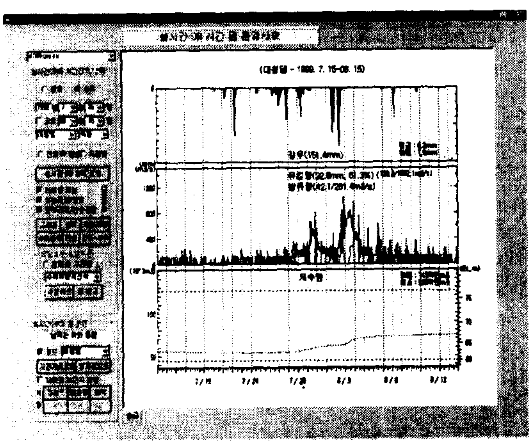

Fig. 9. Results of hourly dam operation

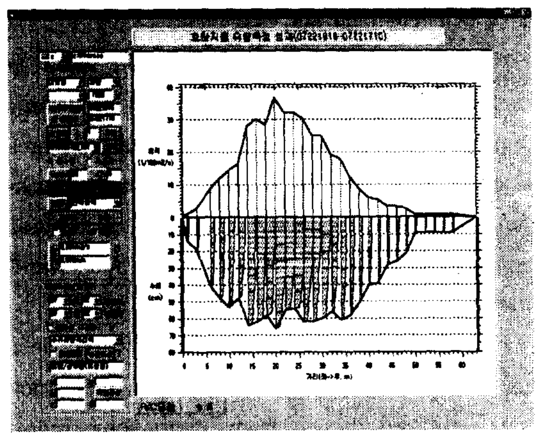

Fig. 10. Accurate streamflow calculation

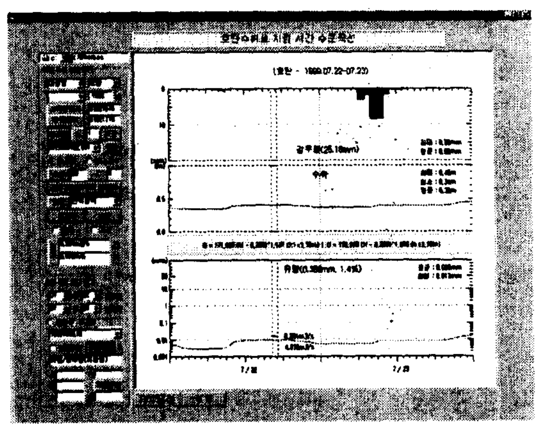

Fig. 11. Overlay of flow to hydrograph

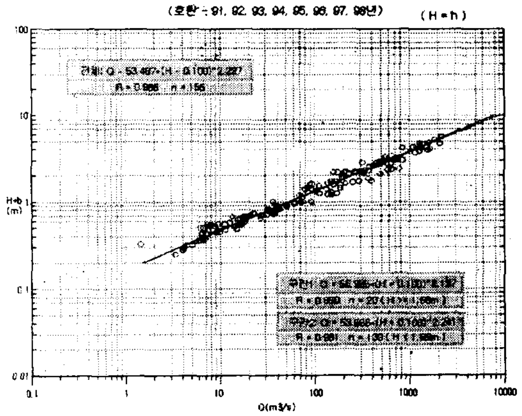

Fig. 12. Overlay of flow to rating curve

rates calculated in Fig. 10.

Fig. 13 is an example of runoff ratio at streamflow gauge stations in the Daechung Dam watershed. The larger the watershed area is, the more the flow volume is and the less the runoff ratio is. Data reliability is decided using the trends of flow volume and runoff ratio with the increase of watershed area.

Fig. 14 shows the comparison between observed flows from the rating curve equation and simulated flows from continuous runoff modeling using the DAWAST model. The rainfall amount is 1,586.0mm while observed and simulated flows are 1,510.3mm and 1,072.2mm, respectively. Runoff ratios of observed and simulated flows show 95.2% and 67.6%, respectively. Large difference between observed and simulated ratios expresses a poor reliability of flow data.

Fig. 15 shows an example of an equal value line of runoff ratio equations as a function of watershed area(km^2) and rainfall amount(mm).

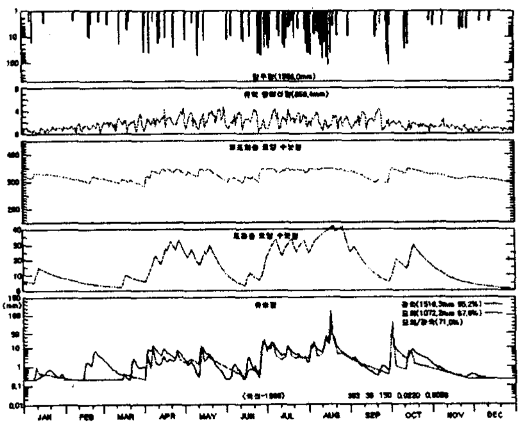

Fig. 14. Evaluation by modeling result

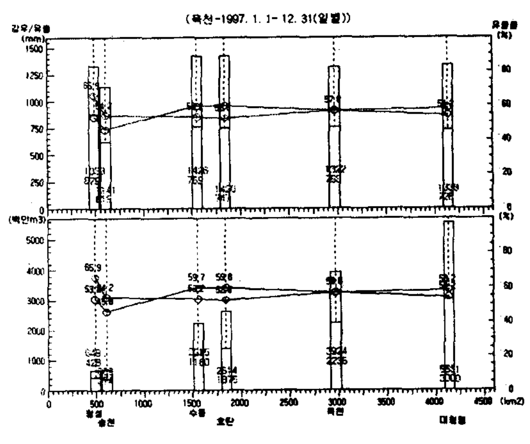

Fig. 13. Flow comparison among stations

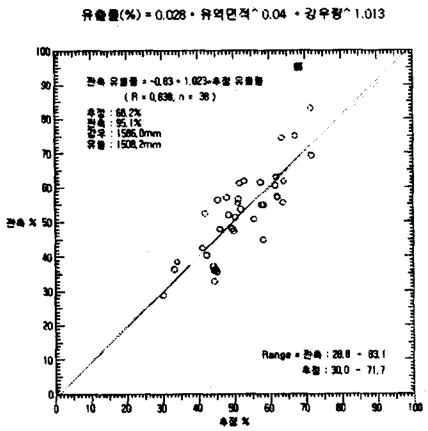

Fig. 15. Evaluation by runoff ratio

Table 1. Rating relationships between water levels and flow rates upstream Daechung dam(1999)

station	watershed area(km^2)	rating eqs. of Q = f(H)	remarks
Okchon	2,957.0	$Q = 82.125 (H - 0.002)^{2.164}$ $Q = 82.528 (H - 0.002)^{2.034}$, $H \geq 0.88$ $Q = 85.281 (H - 0.002)^{2.279}$, $H < 0.88$	from 1999 flow measurements
Hotan	1,909.0	$Q = 107.689 (H - 0.098)^{2.288}$ $Q = 113.476 (H - 0.098)^{2.082}$, $H \geq 1.47$ $Q = 106.353 (H - 0.098)^{2.288}$, $H < 1.47$	〃
Sutong	1,539.0	$Q = 32.371 (H - 0.100)^{2.763}$ $Q = 45.050 (H - 0.100)^{2.039}$, $H \geq 1.09$ $Q = 45.478 (H - 0.100)^{3.602}$, $H < 1.09$	〃
Songchon	619.0	$Q = 44.284 (H - 0.300)^{2.383}$ $Q = 55.141 (H - 0.300)^{2.030}$, $H \geq 1.35$ $Q = 53.112 (H - 0.300)^{2.756}$, $H < 1.35$	〃
Chongsung	484.0	$Q = 53.329 (H - 0.100)^{2.125}$ $Q = 61.961 (H - 0.100)^{1.591}$, $H \geq 1.21$ $Q = 57.988 (H - 0.100)^{2.246}$, $H < 1.21$	〃

Observed runoff ratios marked as square is far from the equal value line. On the other hand, the runoff ratio by equation shows 68.2% and makes good comparison with the simulated result of 67.6% in Fig. 14.

Using the KORSAS system, the above process was successively used to make some decisions on data reliability easily and directly by hydrological practitioners. The evaluation result for the Daechung Dam watershed is summarized in Table 1 and 2.

Table 1 is the rating curve relationship between water levels and flow rates derived by KORSAS using streamflow data in 1999.

Table 2. Flow calculation and evaluation at gauge sites upstream Daechung dam

Station	Year(1999)			Month(2000.4.1-26)			Day(2000.4.26)		Evaluation
	rainfall (mm)	runoff (mm)	ratio (%)	rainfall (mm)	runoff (mm)	ratio (%)	hourly (mm)	daily (mm)	
Daechung dam	1189.9	664.6	55.8	46.8	15.0	32.1	-	0.541	○
Okchon	1217.1	848.3	69.7	41.2	20.8	50.5	0.033	0.790	△
Hotan	1180.0	893.2	75.7	37.2	16.9	45.5	0.032	0.778	△
Sutong	1247.0	543.5	43.6	27.1	3.5	12.8	0.005	0.129	×
Songchon	1212.7	675.2	55.7	44.9	13.2	29.4	0.018	0.432	△
Chongsung	1149.0	585.8	50.9	46.1	4.2	9.1	0.008	0.192	×

Table 2 shows the result of flow evaluations in yearly, monthly, and daily periods. In the yearly result, runoff volumes at Okchon and Hotan were evaluated as high, and runoff volumes at Sutong were low when comparing with the inflow volume to the Daechung Dam. In the monthly result, the runoff volumes at Sutong and Chongsung were low. In the daily result, runoff volumes at Okchon and Hotan were high, and those at Sutong and Chongsung were low.

Generally evaluating by subjective decision, the reliability of data shows intermediate levels at Okchon, Hotan, Songchon, and shows low levels at Sutong and Chongsung. Also, differences between gauge water levels and stream water levels were observed at several observation sites during special field investigations and check-ups. This reduces the quality and reliability of data.

V. Conclusions

A PC-based streamflow evaluation system called KORSAS was developed to decide whether the streamflow data telemetered from the gauging station is reliable or not. It helps the hydrological practitioners in KOWACO to do hydrological work such as streamflow measuring, calculating, analyzing, and evaluating etc.. Using the various methods in KORSAS, suspicious or uncertain data is checked regularly and the reliability of streamflow data is improved by continuous data verification practices.

References

1. Noh, J. K., 1999, '99 annual evaluation report on hydrological observation, Korea Water Resources Corporation, p. 398.
2. Noh, J. K., Y. D. Sung, H. G. Lee, and W. S. Lee, 1999, KOWACO's regular streamflow appraising system(KORSAS), Proceedings of the Korean Society of civil Engineers in 1999, Division of Hydrology, Harbor, and Environment, Kyeongju, Korea, pp. 13~16.
3. Noh, J. K., 1991, Daily watershed streamflow model based on soil water storage, Ph. D. dissertation, Seoul National University.