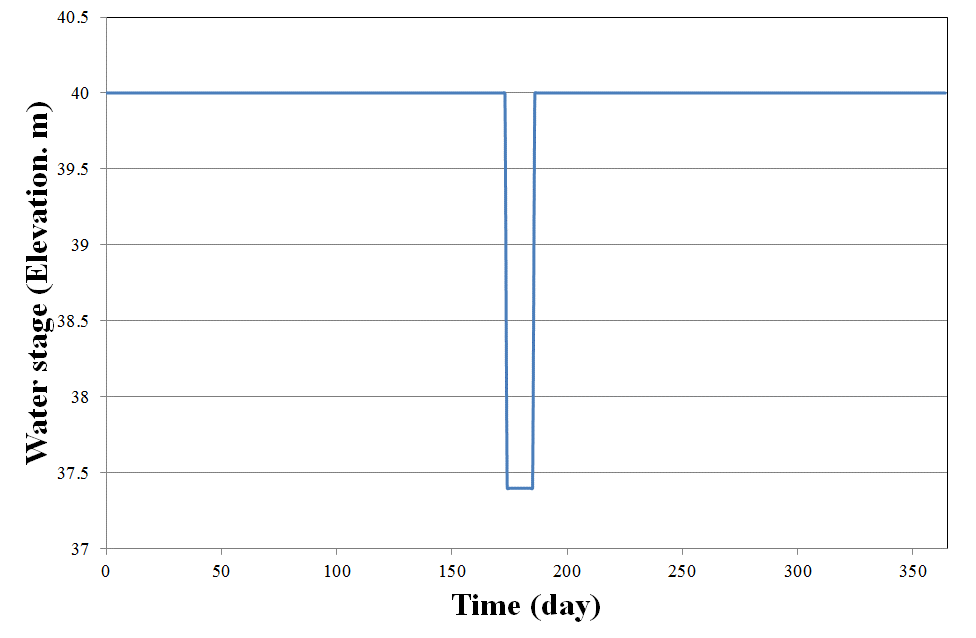
***Supporting File***

***2.3.4. Numerical modelling***

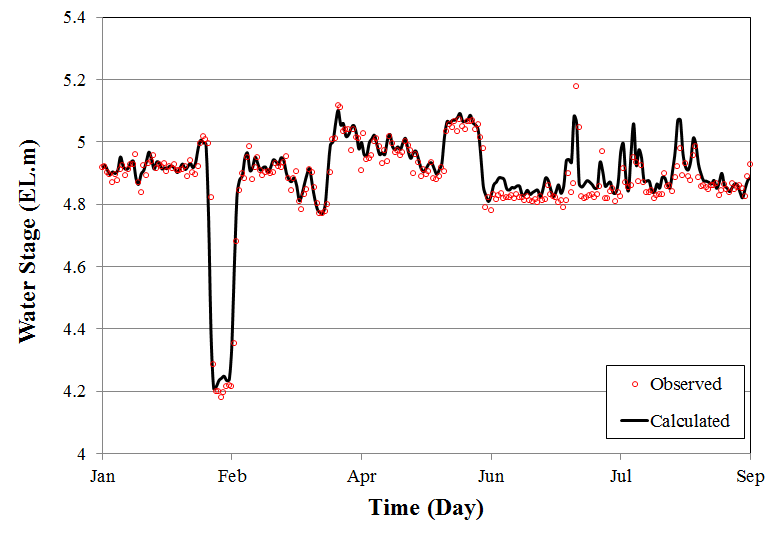
**<HEC-RAS>**

☞ The simulation period and the operational scenario for water level management at the Nakdan Weir are shown in Fig. a. **Fig. a** is a graphical representation of the operating conditions of the management level of the Nakdan weir.

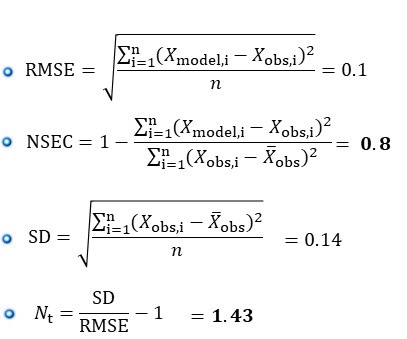


**Fig. a**. Operational scenario for water level management at the Nakdan Weir.

☞ **Fig. b** shows the calculated and observed the water stages. We used RMSE, NSEC, and Nt to evaluate the performance of the HEC-RAS model, as shown in **Table a**.



**Fig. b**. Parameter verification for the water stage calculated by the HEC-RAS model.

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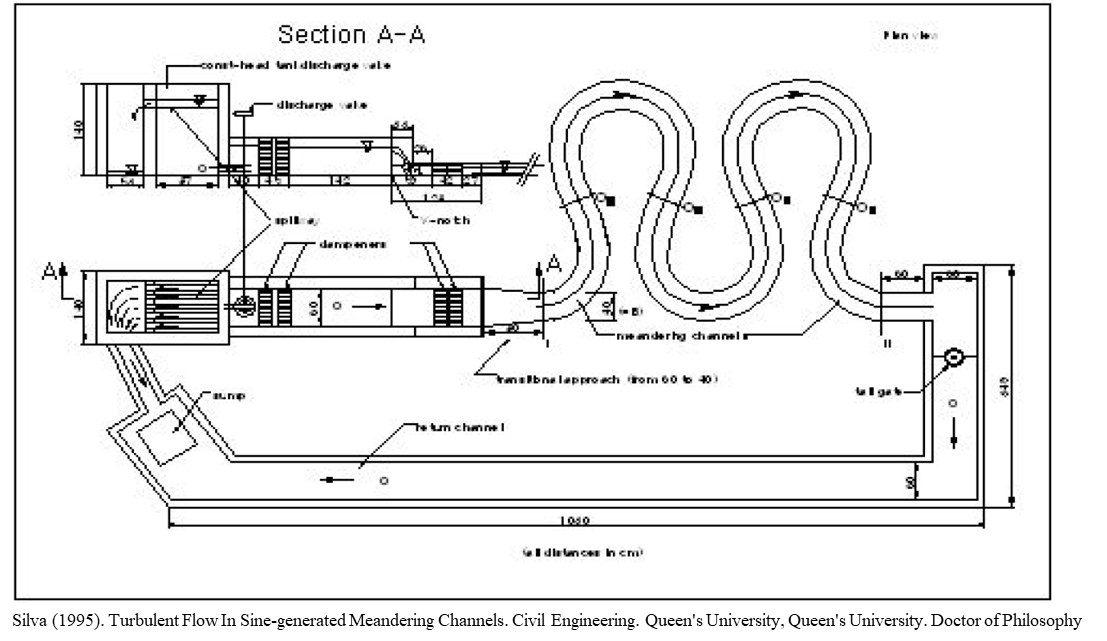
**Table a** Results of performance of the HEC-RAS model

|  |  |  |  |
| --- | --- | --- | --- |
| Performance Rating | Model Efficiency Interpretation |  | NSEC |
| Very good | SD > 3.2 RMSE | >2.2 | >0.90 |
| Good | SD = 2.2 RMSE − 3.2 RMSE | 1.2–2.2 | 0.80–0.90 |
| Acceptable | SD = 1.2 RMSE − 2.2 RMSE | 0.7–1.2 | 0.65–0.80 |
| Unsatisfactory | SD < 1.7 RMSE | >0.7 | <0.65 |

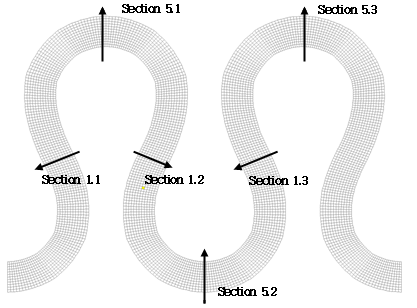
Reference : Ritter, A.; Munoz-Carpena, R. Performance evaluation of hydrological models: Statistical significance for reducing subjectivity in goodness-of-fit assessments. *J. Hydrol*. 2013, *480*, 33–45.

**<EFDC>**

☞ This study comparatively analyzed the experimental value studied by Silva (1995) and the assay value of the multidimensional hydraulic model, based on the hydraulic model experiment conducted by Laboratorio Nacional de Engenharia Civil (LNEC). The result of the hydraulic model experiment by LNEC was used, and the experimental device for the experiment and established EFDC model grid are as shown in **Figures c and d**.

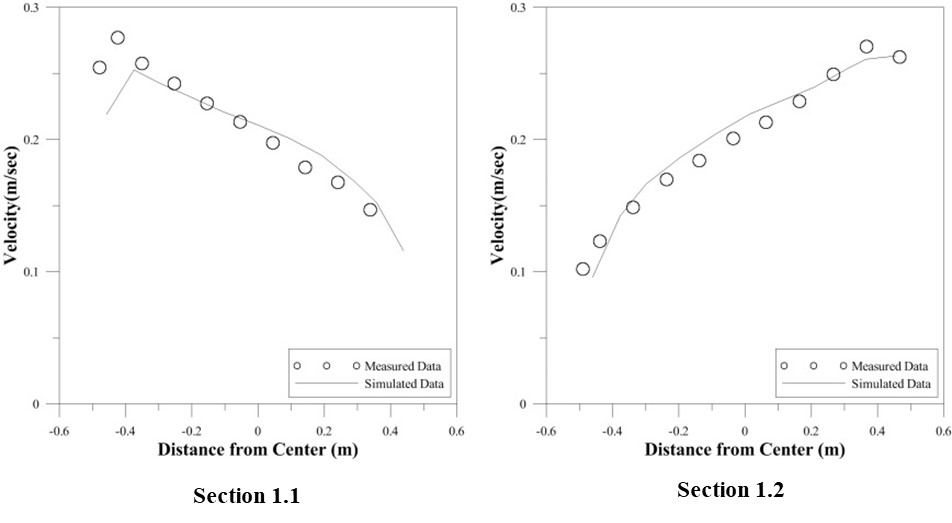
**

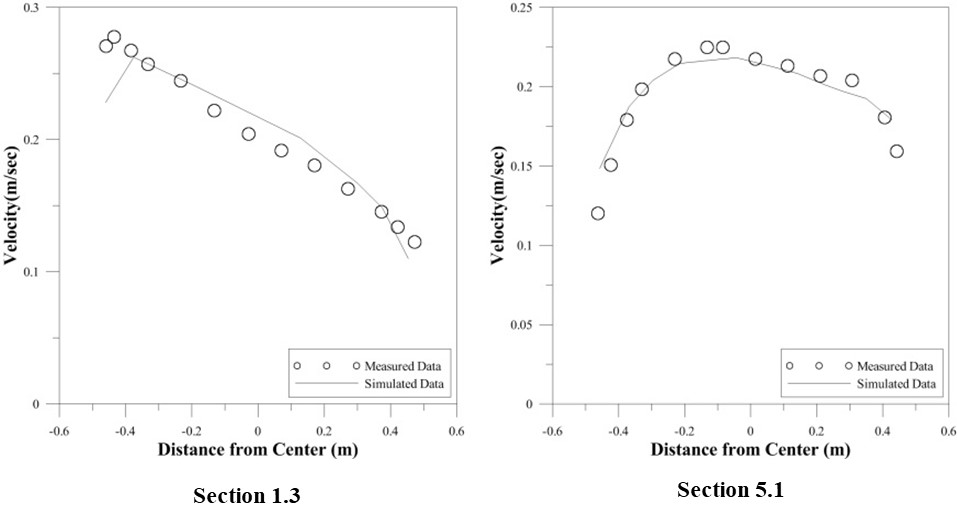
**Fig. c**. Diagram of hydraulic model experiment

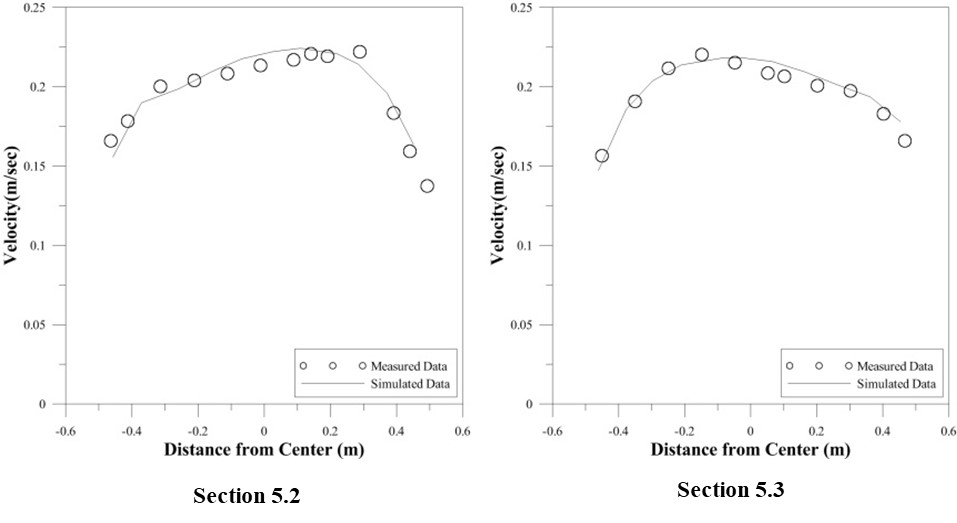
**

**Fig. d.** Grid generation for the hydrodynamic of hydraulic model experiment

☞ **Fig. e** shows a diagram of the flow velocity distribution on the cross section, based on the side of the experimental river channel. As a result, there was little difference in the boundary barrier in which maximum velocity occurs, but overall it was the same.

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**Fig. e.** Results of velocity at each section

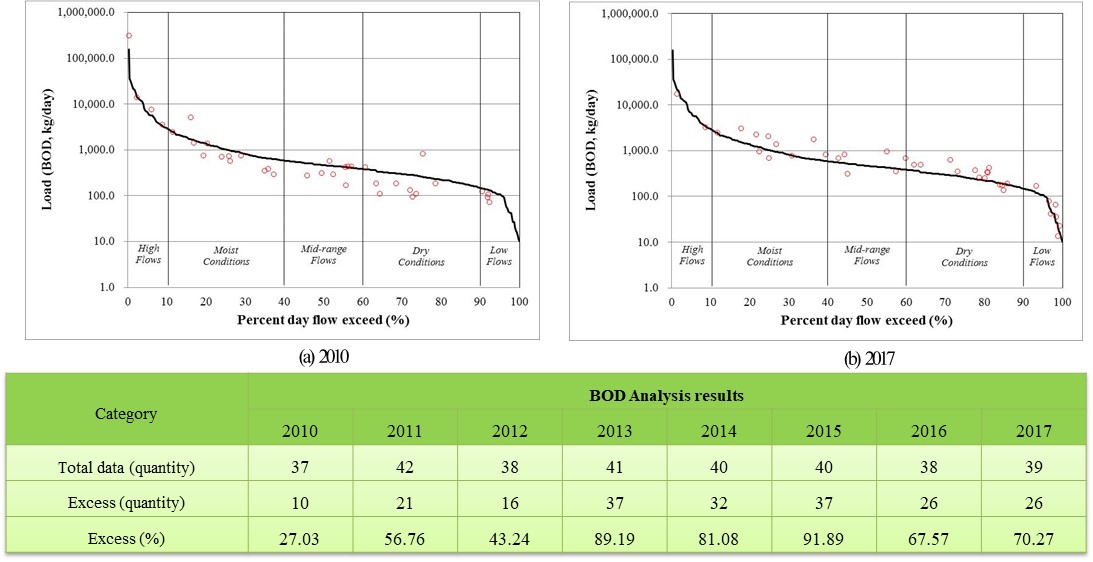
*3.2. SOM and LOWESS*

☞The official list of pollutants in the Wicheon watershed (measured at Wicheon 6) in the TMDL basic plan for Gyeongsangbuk (2015) shows no marked changes in the annual average change rate and has been approved by the Ministry of Environment (**Table b**).

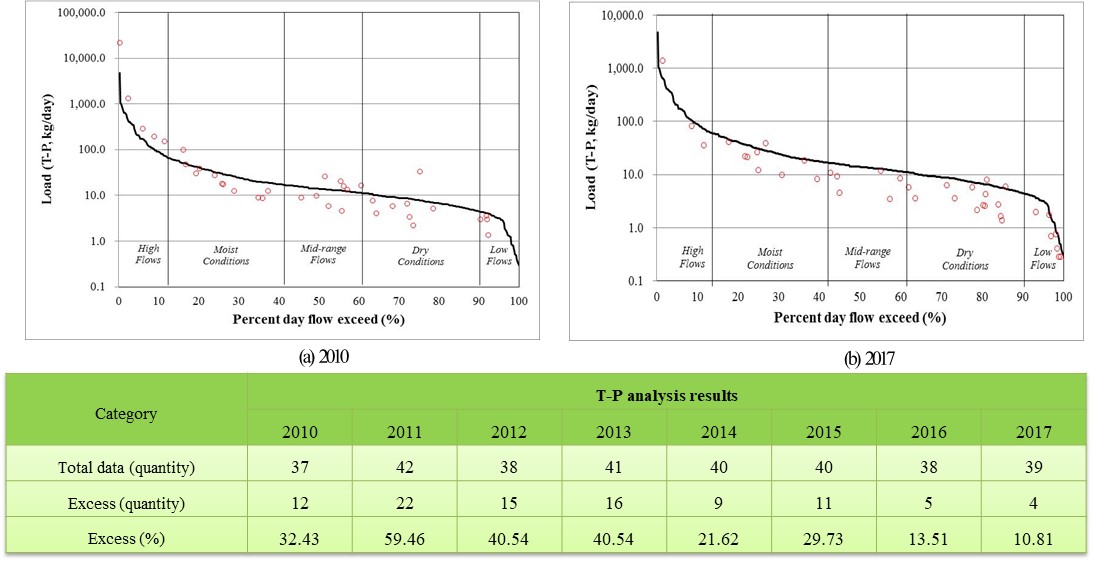
**Table b** Pollutant sources in Wicheon and changes over time as listed in the Gyeongsangbuk-do TMDL basic plan for the Nakdong River water system (15.6.30, approved by the Ministry of Environment).

| Unit watershed | City/Province | Pollutants | | 2008 | 2012  (Existing year) | 2015  (Reference year) | 2020  (Final year) | Annual average change rate |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Wicheon | Gyeongsangbuk-do | Population (persons) | | 49,739 | 47,506 | 47,232 | 45,158 | -0.62% |
| Livestock  breeding  heads  (heads) | Milk cow | 927 | 1,026 | 1,026 | 1,026 | 0.00% |
| Cattle | 24,903 | 28,809 | 30,345 | 32,406 | 1.56% |
| Horse | 0 | 2 | 2 | 2 | 0.00% |
| Pigs | 64,946 | 68,797 | 69,618 | 70,986 | 0.40% |
| Sheep and deer | 752 | 1,069 | 1,069 | 1,069 | 0.00% |
| Dog | 5,146 | 1,485 | 1,485 | 1,485 | 0.00% |
| Poultry | 2,183,338 | 2,624,579 | 2,624,579 | 2,624,579 | 0.00% |
| Sum | 2,280,012 | 2,725,766 | 2,728,123 | 2,731,552 | 0.03% |
| Industrial wastewater generation (㎥/day) | | 1,165.8 | 946.1 | 947.5 | 950.0 | 0.05% |
| Land area  (㎢) | Fields | 59.252 | 60.829 | 60.406 | 60.155 | -0.14% |
| Paddies | 105.326 | 105.172 | 103.869 | 103.140 | -0.24% |
| Woods and fields | 485.219 | 482.345 | 478.337 | 476.772 | -0.14% |
| Building Site | 27.478 | 28.305 | 29.737 | 31.155 | 1.26% |
| Others | 55.517 | 56.080 | 60.382 | 61.509 | 1.21% |
| Sum | 732.792 | 732.731 | 732.731 | 732.731 | 0.00% |

*3.3. LDC*



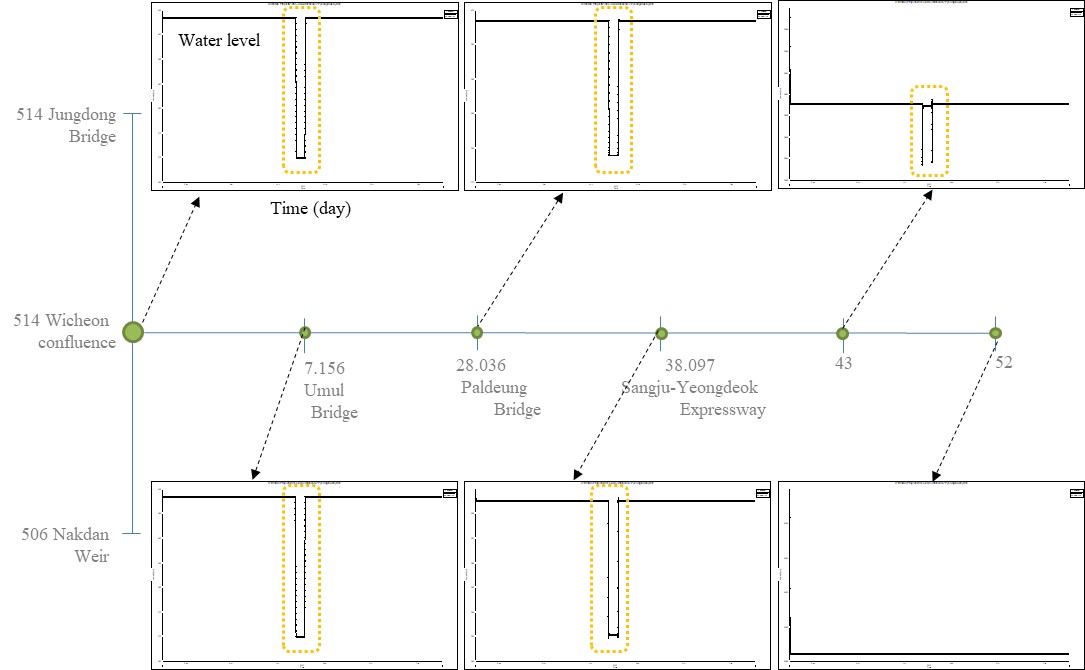
**Fig. f.** LDC analysis results for BOD in (a) 2010 and (b) 2017 with summary data given below.



**Fig. g.** LDC analysis results for TP in (a) 2010 and (b) 2017 with summary data given below.

*3.4. Numerical modelling*

*HEC-RAS modelling*



**Fig. h.** Water level analysis result showing the maximum backwater effect boundary points calculated by the HEC-RAS model.

*EFDC modelling*

|  |  |
| --- | --- |
| 그림입니다. 원본 그림의 이름: CLP00001ac0000f.bmp 원본 그림의 크기: 가로 621pixel, 세로 553pixel | 그림입니다. 원본 그림의 이름: CLP000021ac0011.bmp 원본 그림의 크기: 가로 667pixel, 세로 563pixel |
| (a) | (b) |

**Fig. i**. (a) Interpolated riverbed topography from the Sangju Weir to the Nakdan Weir and (b) grids constructed at the Nakdong-Wicheon confluence.