Hydrometric measurements with quality and accuracy

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Background

- In order to improve accuracy of field measurement, it is necessary to improve relevant technique and use of adequate instrument and analysis method for specific flow conditions.
- Both of Application of advanced technique and improvement of existing method(data measurement, analysis and procedure, QC, assessment) are important
- The main objectives of action plan is to provide a technical report or guideline about three parts of hydrological observation technique
  - Real-time discharge measurement (IRDIMS, Integrated Real-time Discharge Measurement System)
  - Sediment measurement
  - development of rating curve
- Each activity are based on case study for various conditions and practical experience of HSC

Overview of Hydrological measurements in HSC

- Since 2007, HSC has been conducting hydrological measurements in Korea
  - Discharge measurement and rating curve development in over 100 sites
  - Construction and operation of IRDIMS(52 sites are operating)
  - Sediment measurement in 15~20 sites

year	Number of sites						Remarks
	Discharge	IRDIMS	Sediment	Soil moisture	Evapotran-spiration	Survey river-bed	
2004	69	-	-	-	-	-	
2005	73	1	-	-	-	-	
2006	99	4	6	-	-	-	
2007	107	8	6	1	1	-	HSC
2008	109	11	6	2	2	-	
2009	114	13	7	2	2	-	
2010	126	16	20	2	2	-	
2011	121	26	20	2	2	-	
2012	123	46	15	2	2	690km	
2013	146	49	15	2	2	530km	
2014	152	52	15	2	2	690km	
Plan*	380	104	138	25	25		

* National hydrological observation network in Korea

ACTIVITIES

- Hydrometric measurements with quality and accuracy

- **Provide guidance on the use of appropriate instruments and methods of observation in diverse conditions**

  - In terms of use of appropriate instrument and method of observation in diverse conditions, IRDIMS(Integrated Real-time discharge Measurement System) would be a great model and example for real-time discharge measurement in diverse conditions such as backwater and tidally effected area

  - The main purpose of this action is providing technical information and guidance on application of real-time discharge measurement

  - There are two sub actions being conducted in this action plan,

    (1) Collection of the technical information of IRDIMS

    (2) Case study on measurement of IRDIMS (52 sites)

ACTIVITIES

(1) Collection of the technical information of IRDIMS

- This action is collection of various technical information related to real-time measurement, which include (a) measurement instruments, (b) discharge calculation and (c) construction and operation of IRDIMS

(a) Analysis on measurement characteristics of various types of ADVM by specifications of each type and flow condition, is being carried out based on results from IRDIMS stations.

(b) The information related to discharge calculation using IVM(Index Velocity Method) have been collected from 52 stations, which include flow condition, feature of cross section, measuring condition, available range of ADVM, status of developed index rating for each station.

(c) The technical information related to construction and operation of IRDIMS includes process of design and construction, control system, maintenance of instruments, data monitoring and management system.

ACTIVITIES

(2) Case study on measurement of IRDIMS(52 sites)

- Analysis on result of measurement by IRDIMS depending on flow condition, will be conducted and it will contain the procedure on development of index rating. The details are

(a) Measurement in tidally effected area

(b) Measurement in backwater area caused by weir, sluice gate, stream junction

(c) Evaluation of the result of measurement

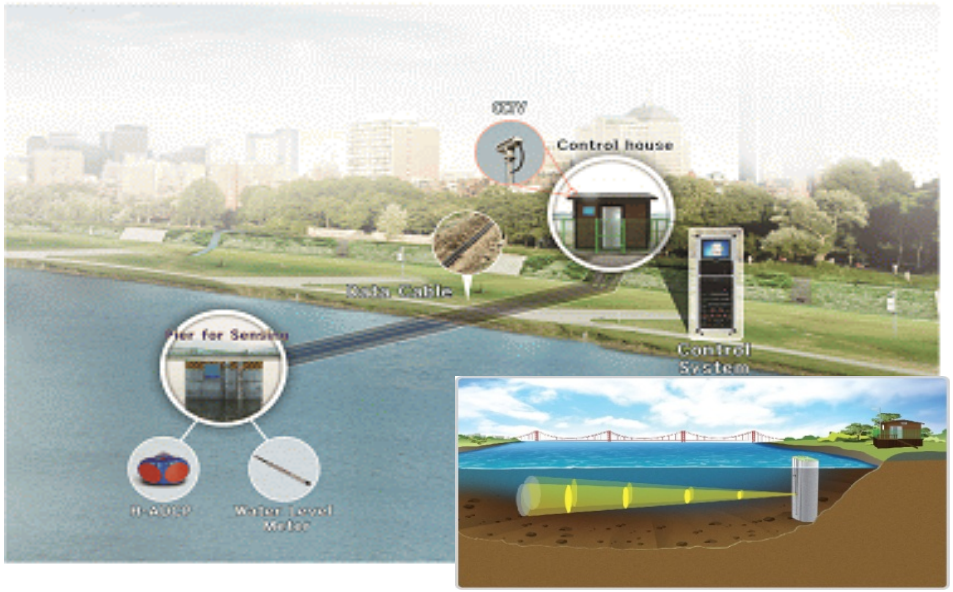
- Comparative analysis using individual measurements
- Assessment of runoff between up and down stream

(d) Development of index rating

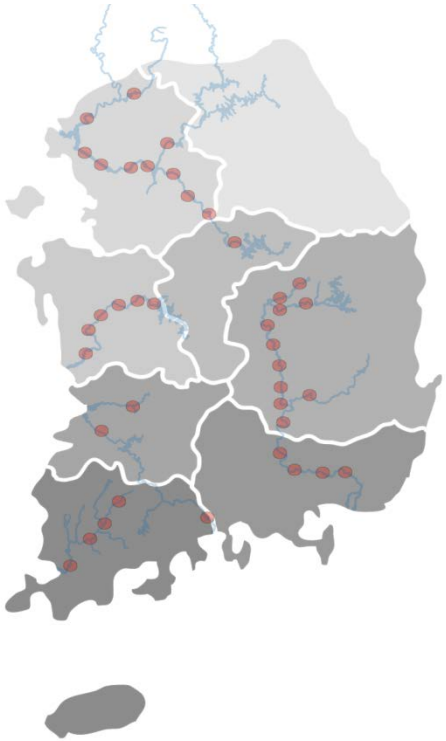
- Analysis on available measurement range of ADVM to calculate index velocity
- Procedure of index rating development and its software tool
- Analysis of index ratings developed for various conditions

Construction and operation of IRDIMS in Korea

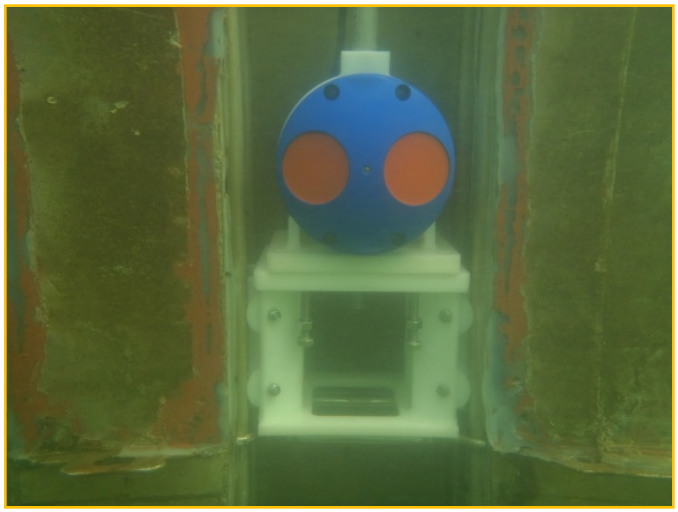
- Integrated River Discharge Measurement System, IRDIMS is widely used to measure real-time flow discharge in Korea
- IRDIMS mainly have been installed in difficult stations to measure discharge due to backwater or tidal effect and key stations to flood forecast
- 52 sts. have been constructed and operating now and it will be extended to more than 100



Total	Han river	Nakdong river	Geum river	Yeongsan river
52	15	22	7	8



Measurement of ADVM



CM-1200kHz

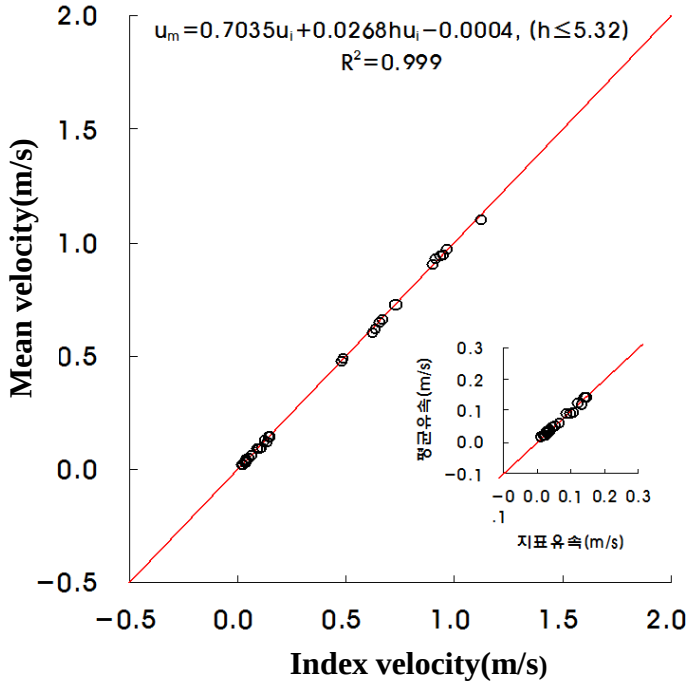
CM-300, 600kHz

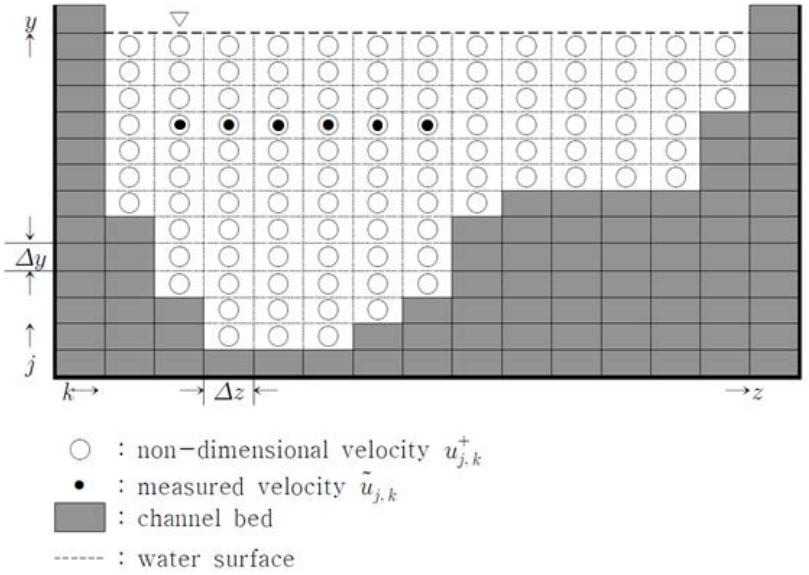
ADP-250, 500kHz

ArgonautSL-500, 1500kHz

Calculation of Discharge

- For real-time discharge measurement by ADVM, it is necessary to calculate mean velocity from ADVM measurement in order to calculate discharge
- **IVM(Index Velocity Method)**
  - Mean velocity is calculated by relationship between index- and mean velocity
  - A number of individual discharge measurements are needed to develop relationship between index- and mean velocity throughout the expected range in stage or mean velocity.
- **VPM(Velocity Profile Method)**
  - Velocity distribution of cross section is estimated by applying theoretical velocity profile

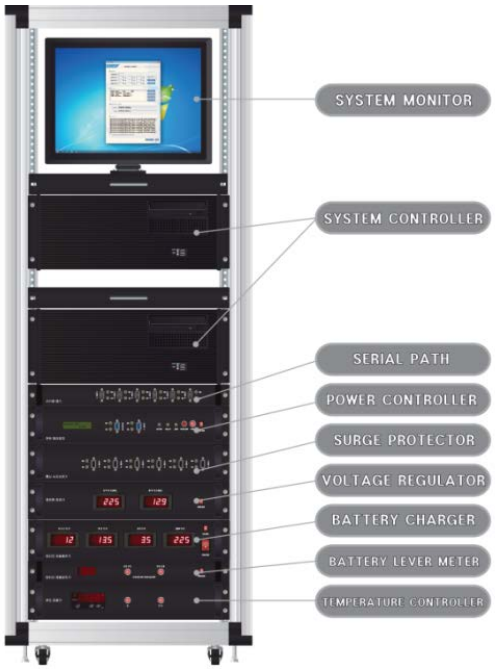




Control System of IRDIMS

Functions of Control system

- Setup of operational configuration and controlling all instruments
- Connection to measuring instruments and data processing
- Real-time data transmission by dual mode of wireless or wired communication
- Protecting all equipment from damage caused by surge and extreme temperature
- Electrical power control
- Providing remote access in on-line



Syetem Monitor
Display of measurement processing

Syetem Controller
Control of all equipments and data proecess

Serial Path
Switch of RS422 to RS232

Power Controller
Control of leading-in electric power

Surge Protector
Protect for all equipments from surge

Voltage Regulator
Supply constant voltage

Battary Charger
Auto charge battary for power cut

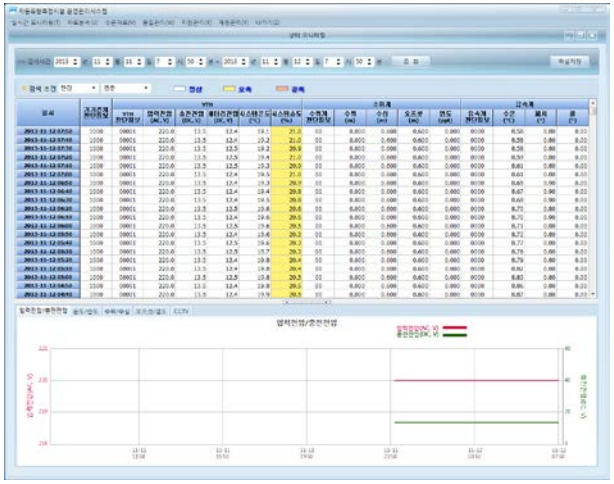
Battary Level Meter
Cutoff of instable voltage from power source

Temperature Controller
Auto control of stabel temperature

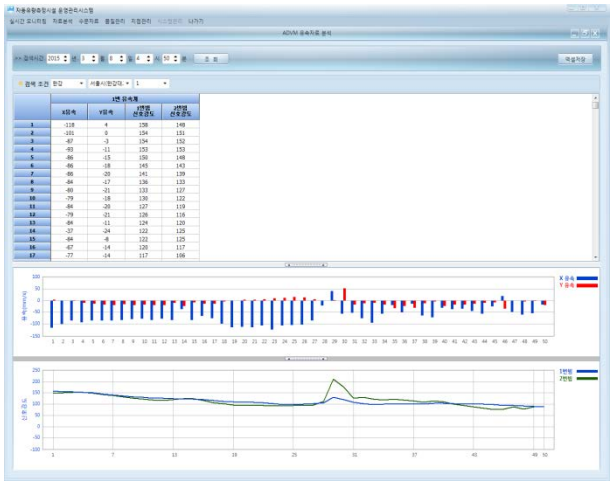
Data monitoring and management system

Main functions of the system

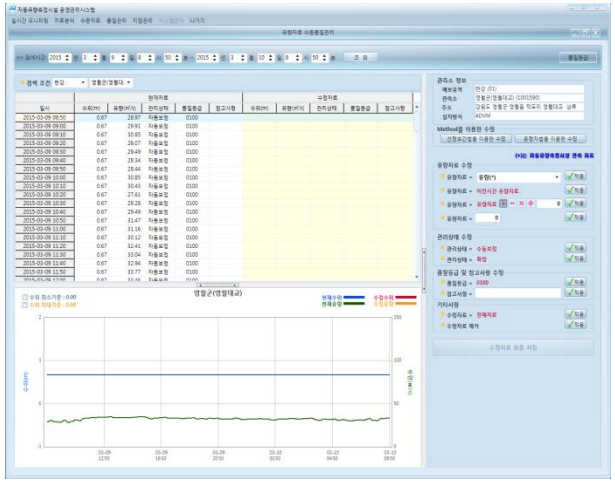
Data monitoring



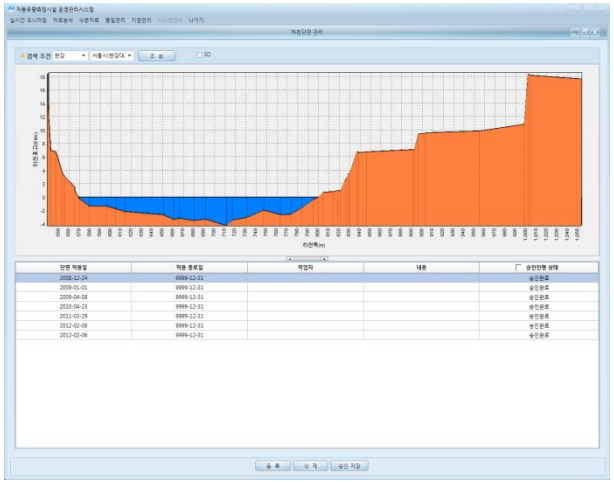
Monitoring of operational conditions



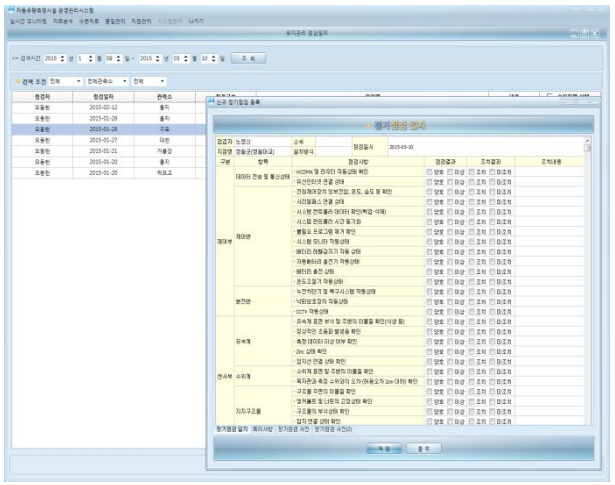
Analysis of velocity profile



Data Q/C



Management of cross-section

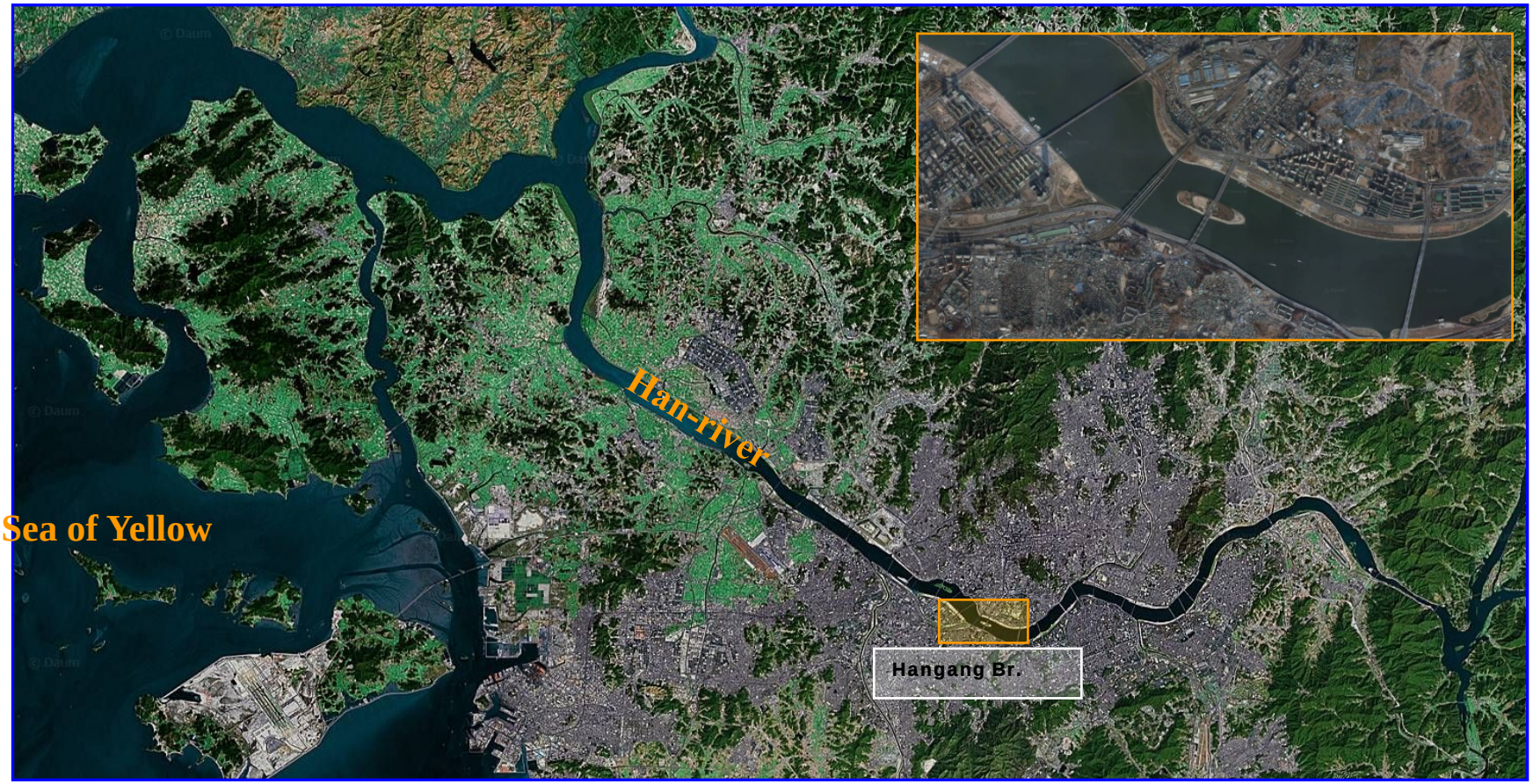


Management of field maintenance

Example Results of IRDIMS

- **Discharge measurement in tidally affected area**

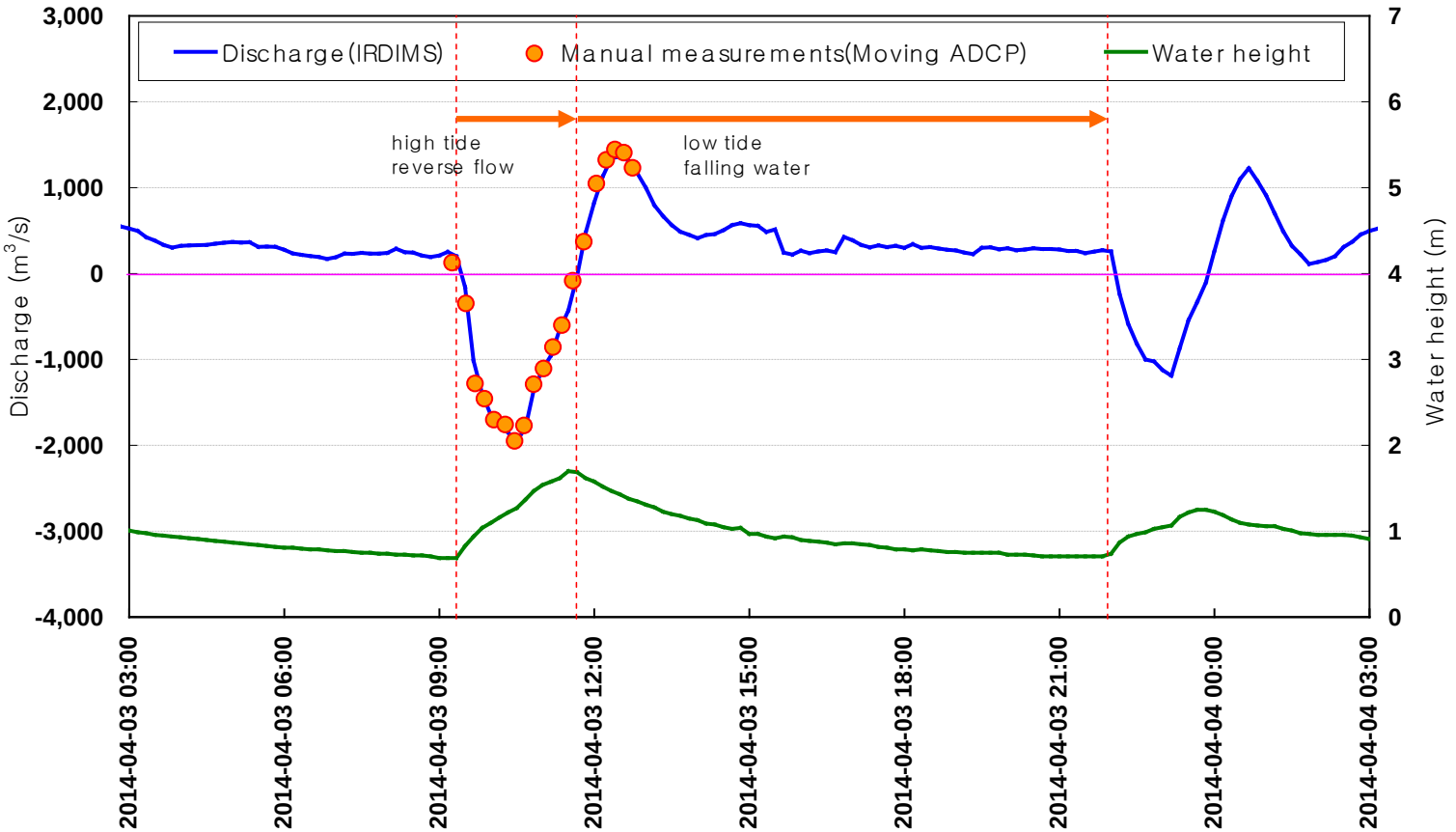
  - Hangang bridge st. is a typical area that is strongly influenced by tide, water height and discharge vary with tidal effect from Yellow sea.



Example Results of IRDIMS

- **Discharge measurement in tidally affected area**

  - Beginning high tide flow, discharge at the station decreased rapidly and flow direction changed to reverse, while water height was rising. After negative peak, reverse flow returned to natural direction and discharge increased and gradually decreased until next tidal period

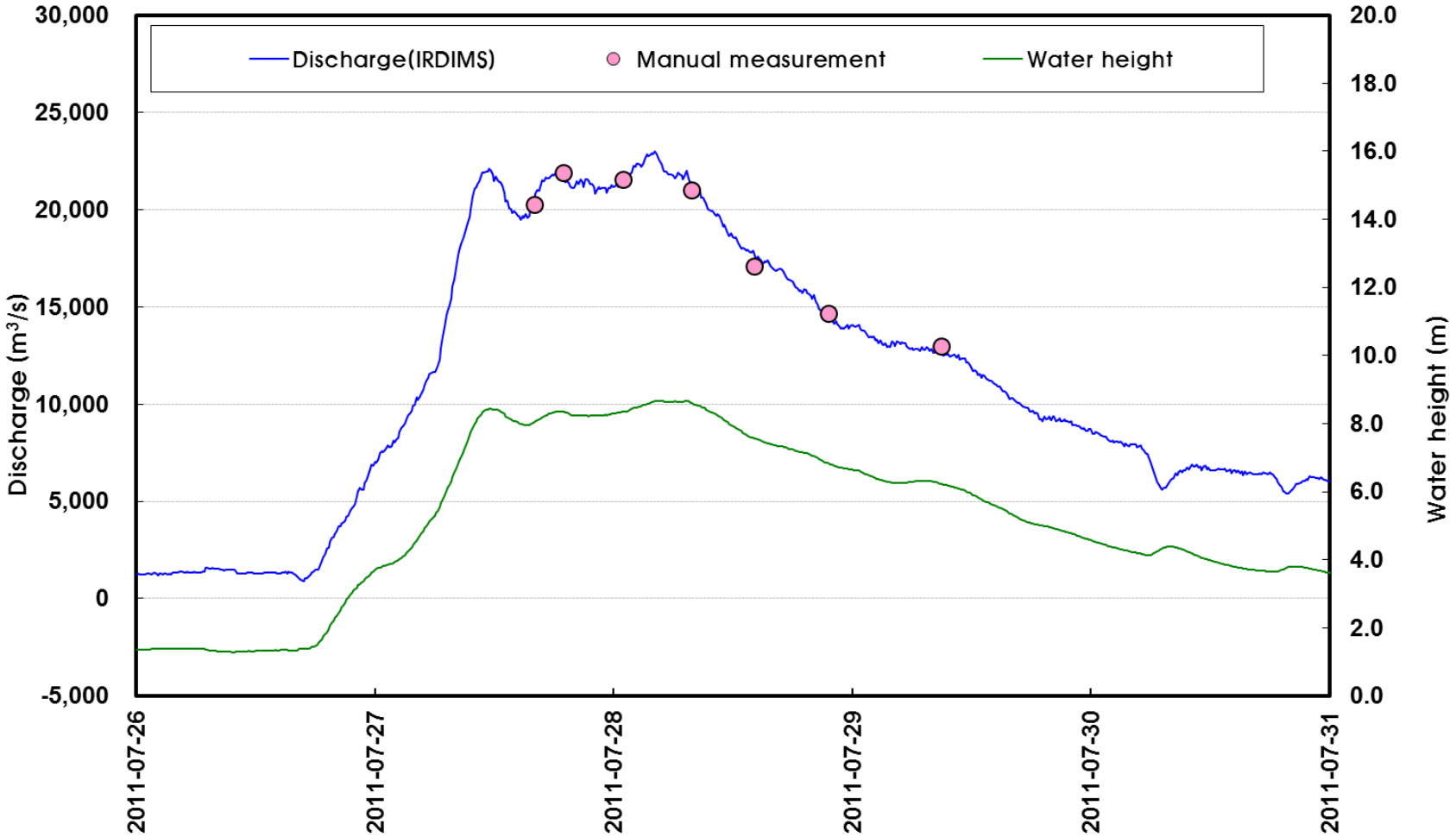


Example Results of IRDIMS

- **Discharge measurement of flood flow**

  - Maximum value : discharge 23,000m^3/s, water level 10.7m, EL., velocity 2.5m/s

    ※ maximum record since IRDIMS began to operate

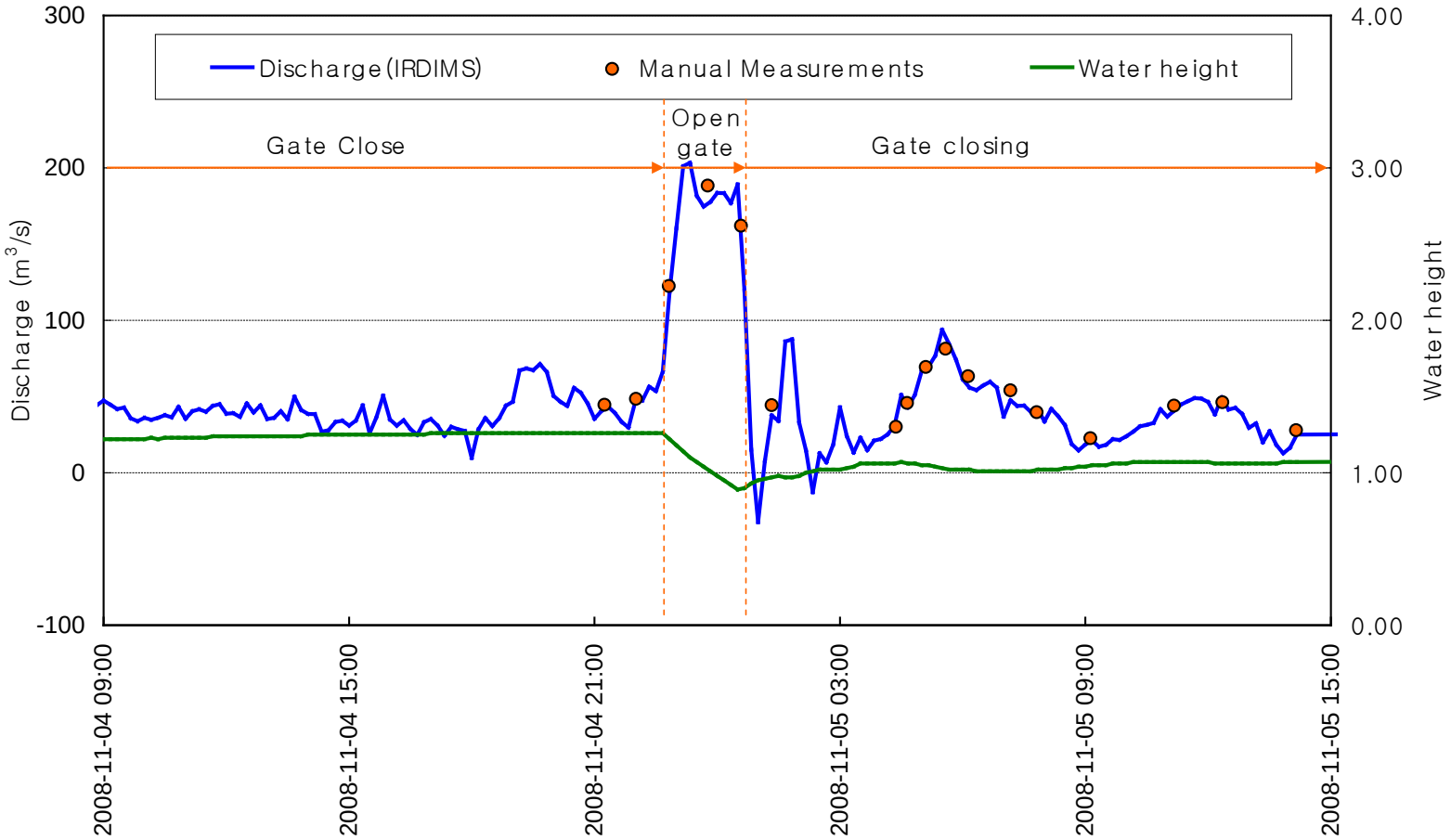


Example Results of IRDIMS

- **Discharge measurement in backwater affected area**
  - Guam station is located in 50km upstream from estuary of Geum River and is affected by backwater from the sea dike sluice

Example Results of IRDIMS

- **Discharge measurement in backwater affected area**
  - Gate operation of the sluice result in flow change of this station.

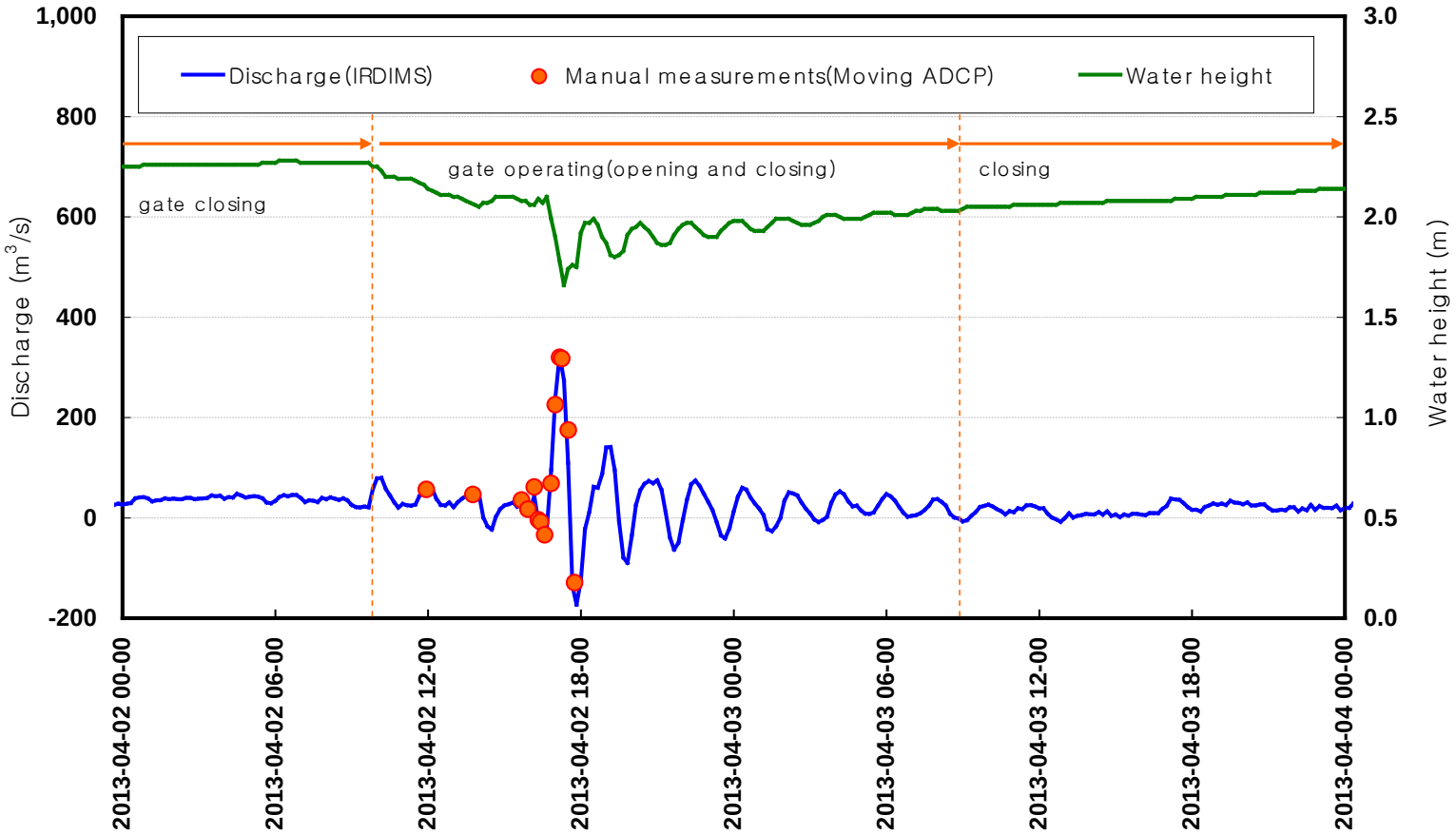


Example Results of IRDIMS

- **Discharge measurement under backwater condition caused by section-crossed structure**
  - Naju station is located at middle of Yeongsan river and affected by operation of Juksan weir in 15km downstream from the station

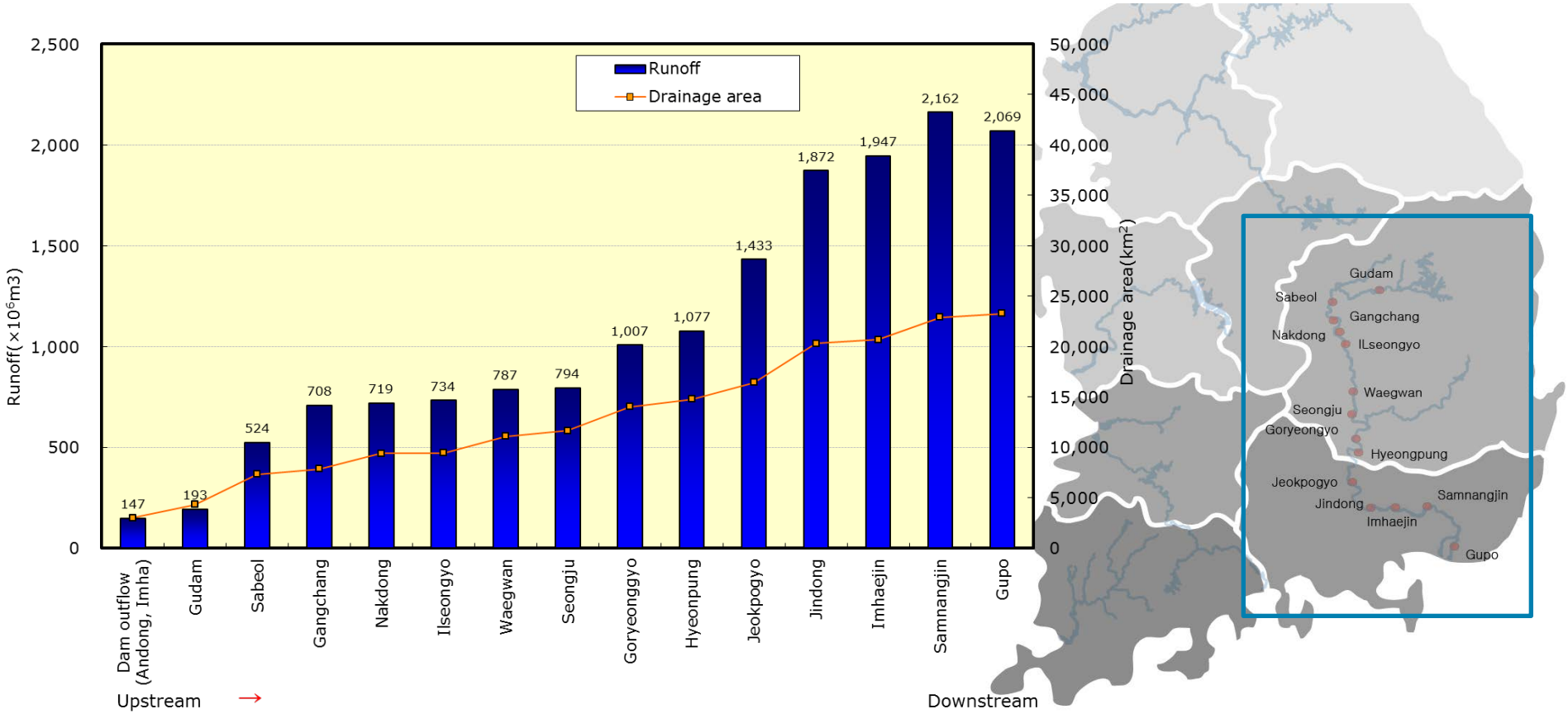
Example Results of IRDIMS

- **Discharge measurement under backwater condition caused by section-crossed structure**
  - Discharge was directly affected by outflow of the weir controlled by gate operation



Example Results of IRDIMS

- **Comparative analysis on runoff of IRDIMS stations**
  - Runoff at each IRDIMS station from upstream to downstream for specific period in Nakdong river
  - Runoff of each station(blue bar) gradually increased from upstream to downstream, and its trend was similar with increasing of drainage area(yellow line).



ACTIVITIES

- Hydrometric measurements with quality and accuracy

Improvement of sediment measuring techniques

- This action is to provide a technical information about sediment measuring instrument and its methodology, and case study on sediment in various conditions

- There are two sub actions being conducted in this action plan, which are

  (1) Collection of technical information related to sediment measurement and analysis

  (2) Case study on sediment measurement in various conditions

ACTIVITIES

- Hydrometric measurements with quality and accuracy

(1) Collection of the technical information related to sediment measurement and analysis

(a) The status of existing sediment measurement technique

- Measurement equipment, methodology and procedure

(b) The status of new technology and its application

(c) Analysis techniques

(2) Case study on sediment measurement in different conditions

(a) Analysis on characteristics of sediment load in rising and falling water level(Loop)

(b) Analysis on river construction effect on characteristic of sediment load, focused on 4 major rivers project in Korea

(c) A comparative analysis on sediment load by sequence of rainfall event.

ACTIVITIES

- Hydrometric measurements with quality and accuracy

Focus on the development of rating curve

- This Activity is to provide a report outlining procedures for developing the optimal rating curve under various conditions in Korea

- The main purpose of this action is providing **technical information** about improved **development procedure** and introducing development tool of rating curve also providing development of **rating curve cases** in various conditions.

- There are two sub actions being conducted in this action plan, these are

(1) Collection of the existing technical information

(2) Case analysis with various field conditions

ACTIVITIES

(1) Collection of the existing technical information

- This action is collection of existing technical information, which include (a) Procedure of rating curve development, (b) Development tool of rating curve

(a) **Procedure** of rating curve development

- Pre-investigation
- Discharge measurement and calculation
- Evaluation of measurement
- Quality Control (QC)
- Confirmation of data
- Evaluation of rating curve

(b) **Software tools** to develop and manage of rating curve and its application

- Data management and QC
  - HDQMS (Hydrological Data Quality Management System)
  - HDIMS (Hydrological Data Information Management System)
- Data analysis and rating curve development (DBPAD, CalPAD)

ACTIVITIES

(2) Case analysis with various field conditions

- This activity is to introduce **many cases of rating curve** development and its practical experionce in **various specific conditions** and suggest adequate methodology and evaluation of results by runoff anlysis etc.

(a) **Development of rating curve in backwater effect**

- Weir, stream junction

(b) Guideline for development of rating curve considering **vegetation**

- Method and procedure of vegetation monitoring

(c) Analysis on effect of **stream environment change** on rating curve

- Bed change, river construction

Stage-discharge rating curve (Rating)

- This continuous record of stage is translated to river discharge by applying the stage-discharge relation (also called rating)

- Stage-discharge relations are developed for streamgages by physically measuring the flow of the river with a mechanical current meter or ADCP at a wide range of stages; for each measurement of discharge there is a corresponding measurement of stage (http://water.usgs.gov/edu)

- **$Q = a X (h-b)^c$**

  (h : stage (water level) , b : Gauge Height os zero flow : GZF , c: slope)

  The stage-discharge relation depends on the shape, slope, and roughness of the channel at the streamgage and is different for every streamgage

- HSC is conduction the flow measurement more than 130 stations per year. Also rating curves was developed from measuring stations per year except a few stations due to tidal or back water effect etc.

The status of flow measurements (2011-2013)

Status of flow measurement the past 2011-2013 years

Hydrological Annual Report in Korea (by Ministry of Land, Infrastructure and Transport)

Year	Flood Control Office	Total Station	Discharge Measurement	Automatic Discharge Measurement	Development of Rating Curve
2011	Han River	47	38	9	44
	Nakdong River	44	35	9	40
	Kum River	29	25	4	29
	Yeongsan River	27	23	4	26
	Total	**147**	**121**	**26**	**139**
2012	Han River	49	39	10	38
	Nakdong River	58	41	17	35
	Kum River	31	27	4	27
	Yeongsan River	35	28	7	25
	Total	**173**	**135**	**38**	**125**
2013	Han River	52	40	12	42
	Nakdong River	60	38	22	39
	Kum River	37	30	7	33
	Total	**189**	**140**	**49**	**147**

The status of development of rating curve (2011-2013)

Status of development of rating curve with various field conditions

Hydrological Investigation Report (by HSC_Ministry of Land, Infrastructure and Transport)

Year	Water System	Weir	Bcckwater of Main River	Discharge of Dam	Sea Wall	Tide	River Constr uction	Vegetation	Curved Channel
2011	Han River	9	4	11	1	1	4	3	1
	Nakdong River	13	5	8	1	2	13	2	2
	Kum River	6	5	10	1	-	4	2	1
	Yeongsan River	6	3	10	-	1	4	1	-
2012	Han River	9	4	4	-	-	5	6	2
	Nakdong River	13	7	0	-	-	2	5	3
	Kum River	5	5	3	1	-	3	5	-
	Yeongsan River	7	5	6	-	-	2	1	-
2013	Han River	3	6	4	1	1	12	4	2
	Nakdong River	5	1	5	-	-	5	1	1
	Kum River	3	2	2	-	-	2	1	-
	Yeongsan River	8	4	19	-	-	3	3	-

Procedure of rating curve development

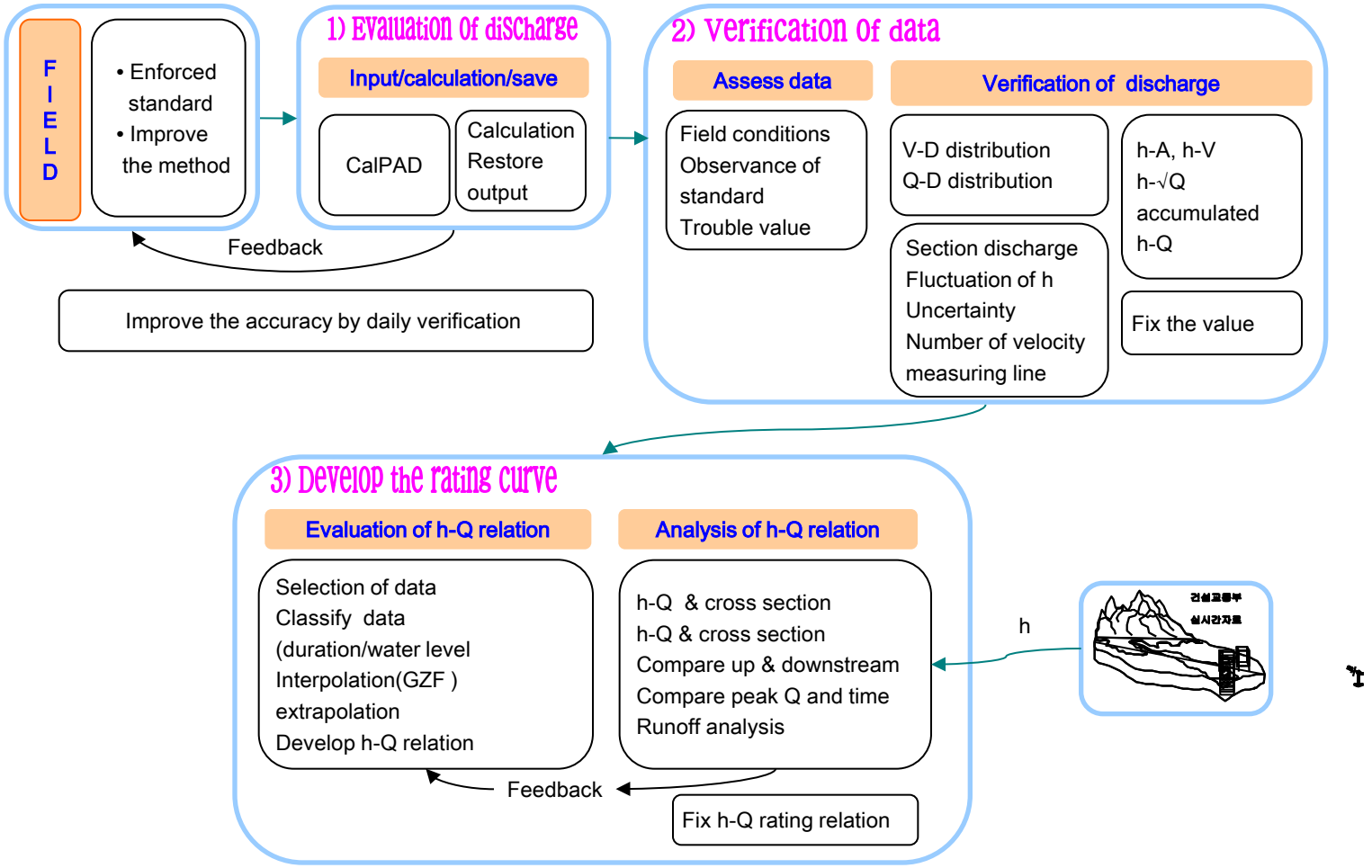
- **Procedure of rating curve development is**

  Pre-investigation – flow measurement – QC of measured data – Development of rating - Evaluation

Major Procedure	Main Contents
Pre-Investigation	- Collecting of past material, Pre-investigation for field measurement - Planning for hydrological observation considering the field conditions
Discharge Measurement and Calculation	- Standards compliance and decision of measuring method, measurement location considering the field conditions - Calculation using standard-calculation sheet
Evaluation of data	- Compliance with standards about measured data, Uncertainty evaluation - Error review of survey method and calculation
Quality Control(QC)	- Error analysis and supplementation according to results of valuation of data - Reflected on future measurement
Confirmation Of data	- Confirmation of data through the data revaluation
Evaluation of rating curve	- Development of rating curve - Accuracy evaluation of rating curve - Runoff analysis etc.

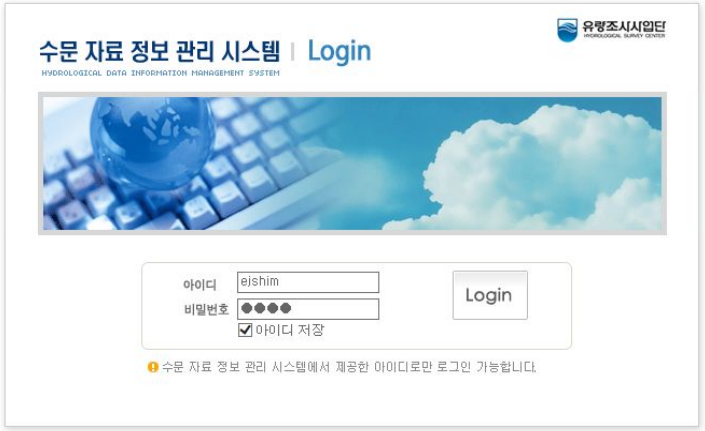
Software tool to development and manage of rating curve

- **HDQMS** (Hydrological Data Quality Management System)

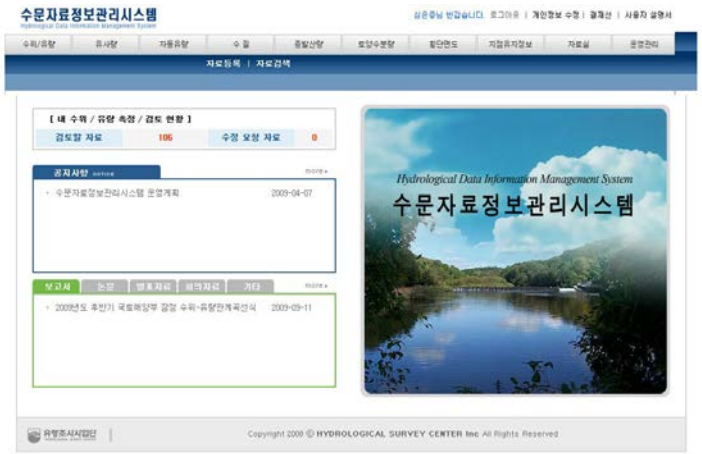


Software tool to development and manage of rating curve

- **HDIMS** (Hydrological Data Information Management System)

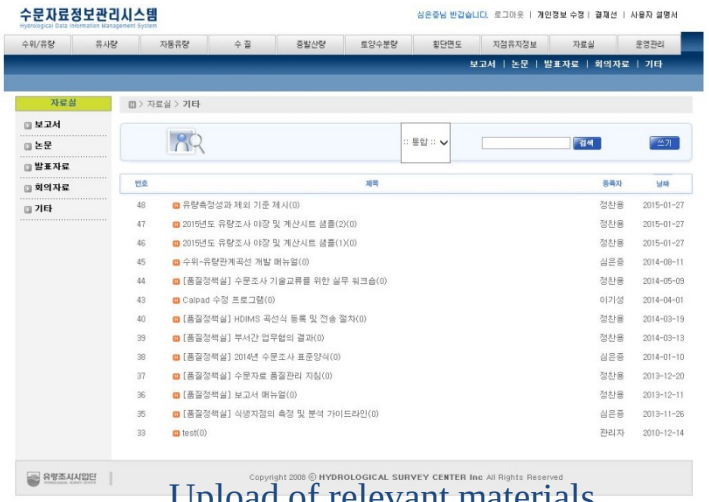


Main Screen (Log-in)



Examination of data (Electronic system)

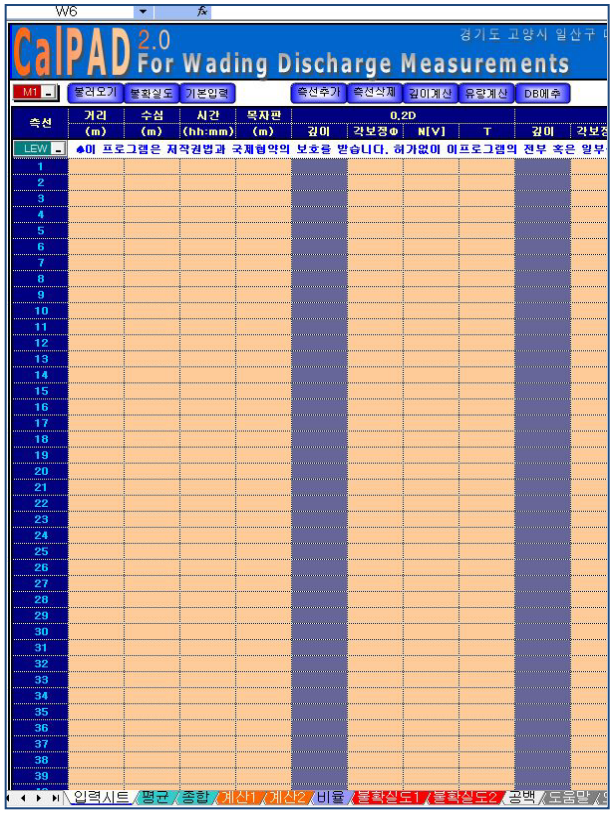
Request of data review



Upload of relevant materials

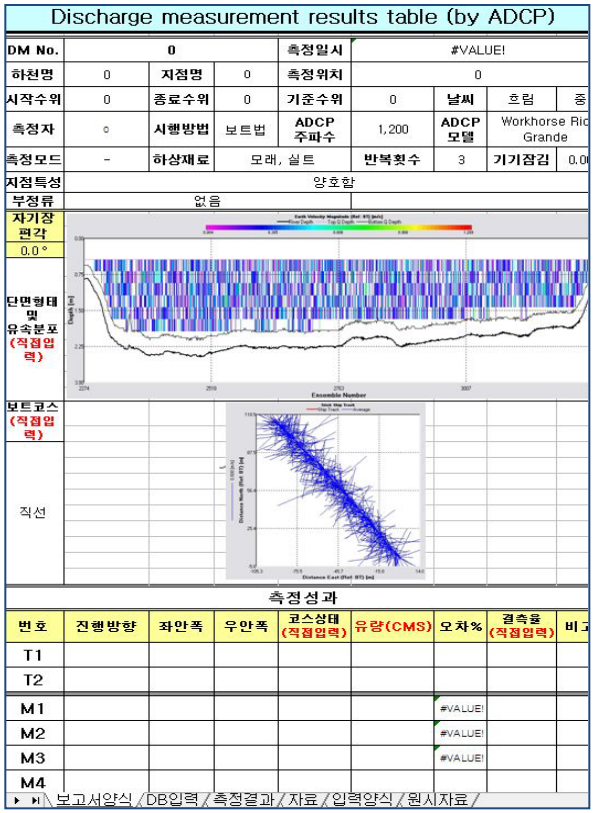
Software tool to development and manage of rating curve

- **Data analysis and rating curve development (DBPAD, CalPAD)**
- Computation sheet of discharge by measuring instrument



CalPAD
(measured by current meter)

FloatPAD
(measured by float)



ADVM sheet
(measured by ADCP)

Software tool to development and manage of rating curve

- **Data analysis and rating curve development** (DBPAD)

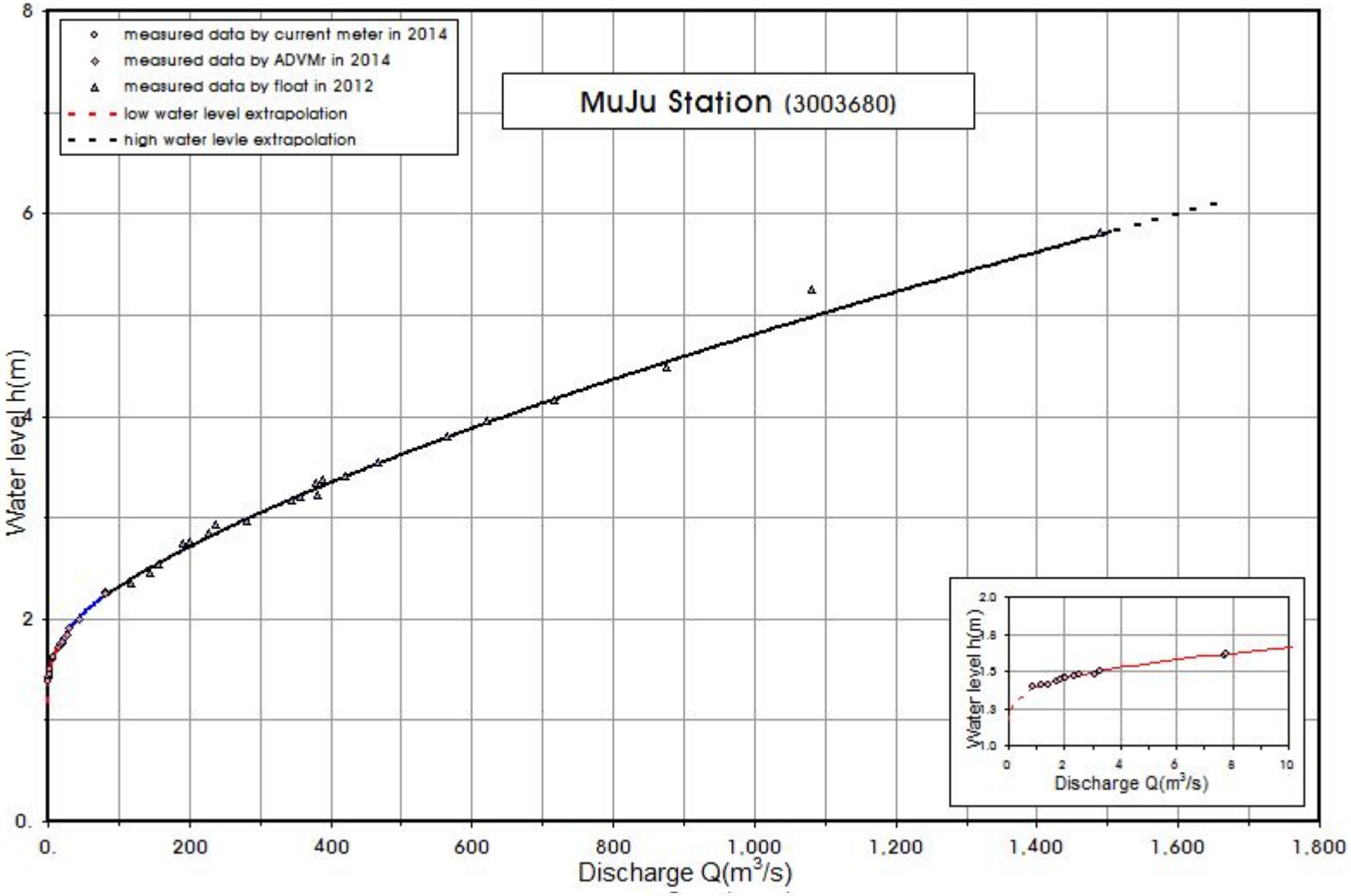
유량측정성과(지점명) HSC2011 K.S.Lee 자료추가 환산수위 (H=h+?) 최대 1,3 1,3 최저 0,13 0,13

DM No	측정 일시 (yy-mm-dd hh:mm)	수위 H (m)	수면폭 (m)	단면적 (㎡)	평균유속 (m/sec)	유량 (㎥/sec)	측정장비 (유속계종류)	유속 측선수	구간유량비(%) 최대	최소	평균	무작위 X'm (%)	계통 X''b (%)	X''d (%)	X''c (%)	X'Q 무작위	X''Q 계통	불확
3101640_14_001	2014-01-23 14:20	0,20	56,00	5,82	0,21	1,20	Flow-Tracker	38	6,38	0,87	2,63	2,00	0,50	0,50	1,00	4,08	1,22	
3101640_14_002	2014-02-13 13:26	0,21	55,50	5,67	0,21	1,21	Flow-Tracker	34	6,81	0,79	2,94	2,20	0,50	0,50	1,00	4,32	1,22	
3101640_14_003	2014-02-26 16:20	0,19	56,00	5,31	0,18	0,97	Flow-Tracker	34	6,08	0,26	2,94	2,20	0,50	0,50	1,00	4,38	1,22	
3101640_14_004	2014-03-25 14:50	0,20	55,50	5,32	0,18	0,98	Flow-Tracker	34	6,34	1,00	2,94	2,20	0,50	0,50	1,00	4,41	1,22	
3101640_14_005	2014-04-15 15:51	0,16	55,50	3,91	0,16	0,61	Flow-Tracker	34	7,77	0,83	2,94	2,20	0,50	0,50	1,00	4,63	1,22	
3101640_14_006	2014-04-25 11:40	0,18	56,00	4,39	0,19	0,82	Flowtracker	35	6,11	0,27	3,23	2,00	0,50	0,50	1,00	4,29	1,22	
3101640_14_007	2014-05-13 12:00	0,25	55,50	7,74	0,25	1,94	Flowtracker	35	5,81	0,94	3,23	2,00	0,50	0,50	1,00	4,16	1,22	
3101640_14_008	2014-05-28 16:25	0,19	55,70	5,13	0,15	0,78	Flowtracker	37	7,24	0,70	3,03	2,00	0,50	0,50	1,00	4,48	1,22	
3101640_14_009	2014-06-17 15:25	0,19	55,50	4,90	0,18	0,90	Flowtracker	34	6,90	0,82	3,33	2,20	0,50	0,50	1,00	4,39	1,22	
3101640_14_010	2014-06-24 12:03	0,22	56,50	6,81	0,22	1,53	Flowtracker	36	5,61	1,56	3,13	2,00	0,50	0,50	1,00	3,96	1,22	
3101640_14_011	2014-07-02 14:22	0,15	55,50	3,14	0,13	0,40	Flowtracker	36	7,53	0,04	3,13	2,00	0,50	0,50	1,00	4,52	1,22	
3101640_14_012	2014-07-10 14:00	0,22	55,50	6,46	0,21	1,36	Flowtracker	34	8,11	1,11	3,33	2,20	0,50	0,50	1,00	4,34	1,22	
3101640_14_013	2014-07-17 12:50	0,13	55,00	2,31	0,09	0,21	Flowtracker	43	5,93	0,00	2,56	2,00	0,50	0,50	1,00	4,23	1,22	
3101640_14_014	2014-07-23 14:42	0,54	56,00	21,06	0,78	16,49	프라이스 AA	37	4,79	0,67	3,03	2,00	0,50	0,50	1,00	3,61	1,22	
3101640_14_015	2014-07-23 15:34	0,51	56,00	20,17	0,75	15,05	프라이스 AA	37	4,81	0,65	3,03	2,00	0,50	0,50	1,00	3,61	1,22	
3101640_14_016	2014-07-23 16:30	0,49	56,00	19,66	0,69	13,64	프라이스 AA	37	5,00	0,61	3,03	2,00	0,50	0,50	1,00	3,62	1,22	
3101640_14_017	2014-07-24 13:31	0,31	56,00	10,57	0,36	3,76	Flowtracker	36	6,64	0,80	3,13	2,00	0,50	0,50	1,00	3,97	1,22	
3101640_14_018	2014-07-25 11:40	0,40	56,00	15,04	0,50	7,49	Flowtracker	35	6,34	0,55	3,23	2,00	0,50	0,50	1,00	3,87	1,22	
3101675_14_019	2014-08-03 14:34	0,27	55,50	8,99	0,31	2,78	프라이스 AA	36	5,52	0,82	3,13	2,00	0,50	0,50	1,00	3,71	1,22	
3101640_14_020	2014-08-13 15:20	0,25	55,00	8,74	0,29	2,53	Flowtracker	34	6,57	0,57	3,33	2,20	0,50	0,50	1,00	4,13	1,22	
3101640_14_021	2014-08-18 12:06	0,33	56,00	11,57	0,39	4,50	프라이스 AA	35	5,92	0,99	3,23	2,00	0,50	0,50	1,00	3,83	1,22	
3101640_14_022	2014-08-19 13:26	0,30	56,00	10,85	0,39	4,28	프라이스 AA	35	6,56	0,67	3,23	2,00	0,50	0,50	1,00	3,84	1,22	
3101640_13_023	2014-08-21 13:20	1,05	39,06	64,26	1,05	67,20	부자	14	11,23	4,93	8,33							
3101640_13_024	2014-08-21 17:58	1,11	39,21	68,12	1,05	71,82	부자	14	9,89	5,14	8,33							
3101640_13_025	2014-09-03 14:05	0,80	38,51	50,37	0,84	42,26	부자	13	13,80	4,22	9,09							
3101640_13_024	2014-09-03 14:36	0,78	38,46	49,32	0,84	41,34	부자	13	12,63	3,88	9,09							
3101640_13_027	2014-09-03 15:21	0,75	38,40	47,74	0,80	38,08	부자	13	14,75	5,54	9,09							
3101640_13_028	2014-09-03 16:00	0,72	38,33	46,75	0,70	32,89	부자	14	14,64	4,87	8,33							
3101640_13_029	2014-09-03 16:40	0,70	38,28	45,69	0,70	32,14	부자	14	14,65	4,86	8,33							
3101640_14_030	2014-09-17 11:52	0,28	55,50	9,92	0,33	3,32	Flowtracker	35	5,17	0,73	3,23	2,00	0,50	0,50	1,00	3,94	1,22	
3101640_14_031	2014-10-16 12:00	0,23	55,90	7,04	0,23	1,60	Flowtracker	38	5,49	0,05	2,94	2,00	0,50	0,50	1,00	3,91	1,22	
3101640_13_032	2014-10-21 13:51	1,13	39,25	68,90	0,92	63,19	부자	14	15,08	5,13	8,33							
3101640_13_033	2014-10-21 15:08	1,23	39,48	74,40	0,98	73,12	부자	14	15,42	5,31	8,33							
3101640_13_034	2014-10-21 15:58	1,25	39,52	75,50	1,01	76,29	부자	14	15,46	4,46	8,33							
3101640_13_035	2014-10-21 16:40	1,30	39,63	78,26	1,03	80,71	부자	14	15,18	5,00	8,33							
3101640_13_036	2014-10-21 18:30	1,25	39,51	75,22	1,08	81,16	부자	14	15,50	4,96	8,33							
3101640_14_037	2014-11-04 14:21	0,28	56,00	9,41	0,30	2,83	Flowtracker	36	5,96	0,47	3,13	2,00	0,50	0,50	1,00	3,93	1,22	

DB / H_A,V,Q / 기타 / 기타2 / 단면 / 과거실과(DB) / 과거레이팅 / 수위-유량(과거)_신대 / 수위-유량(과거)_대대 / 수위-유량_신대 / 수위-유량_대

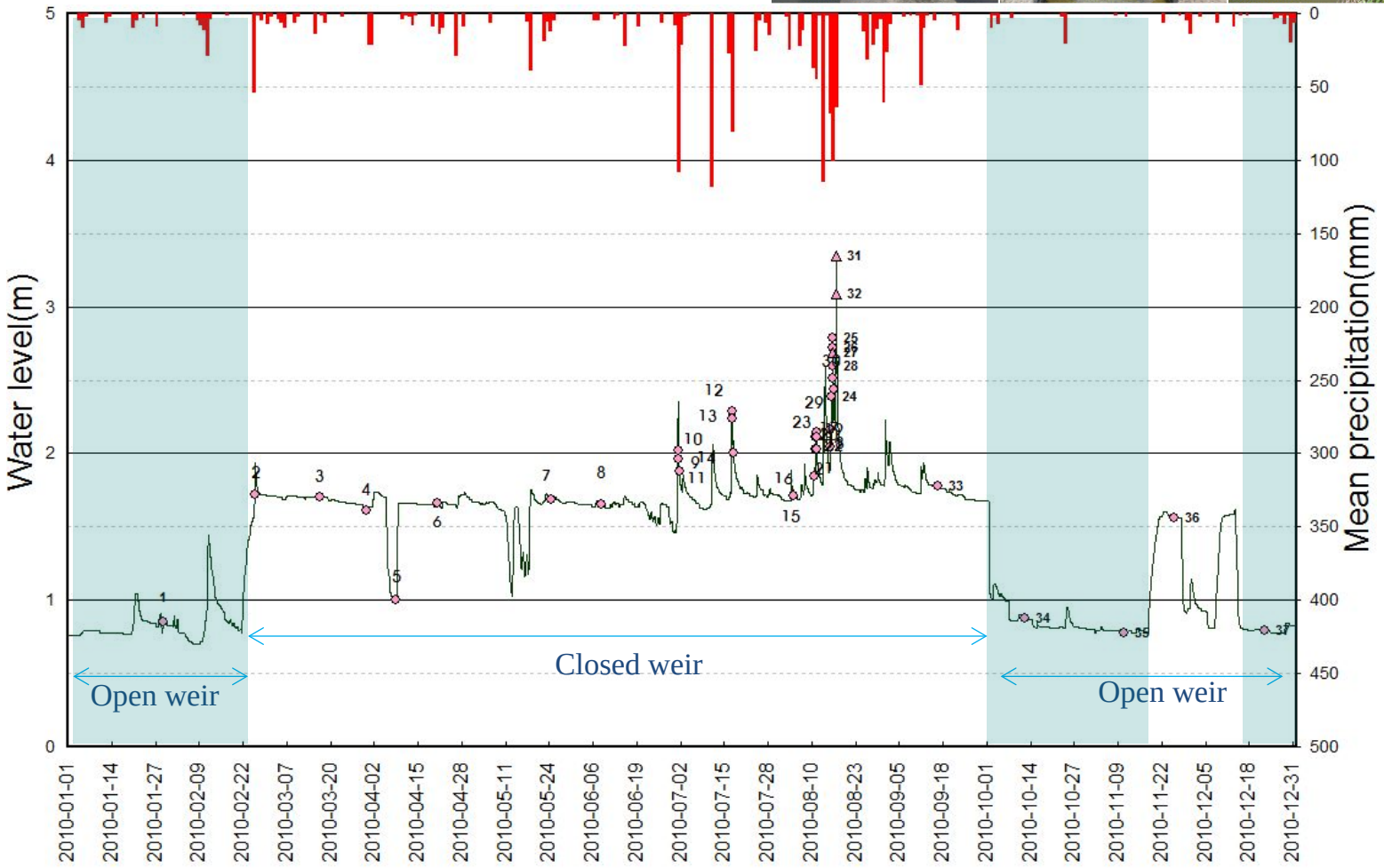
Software tool to development and manage of rating curve

- **Rating curve standard form in HSC**



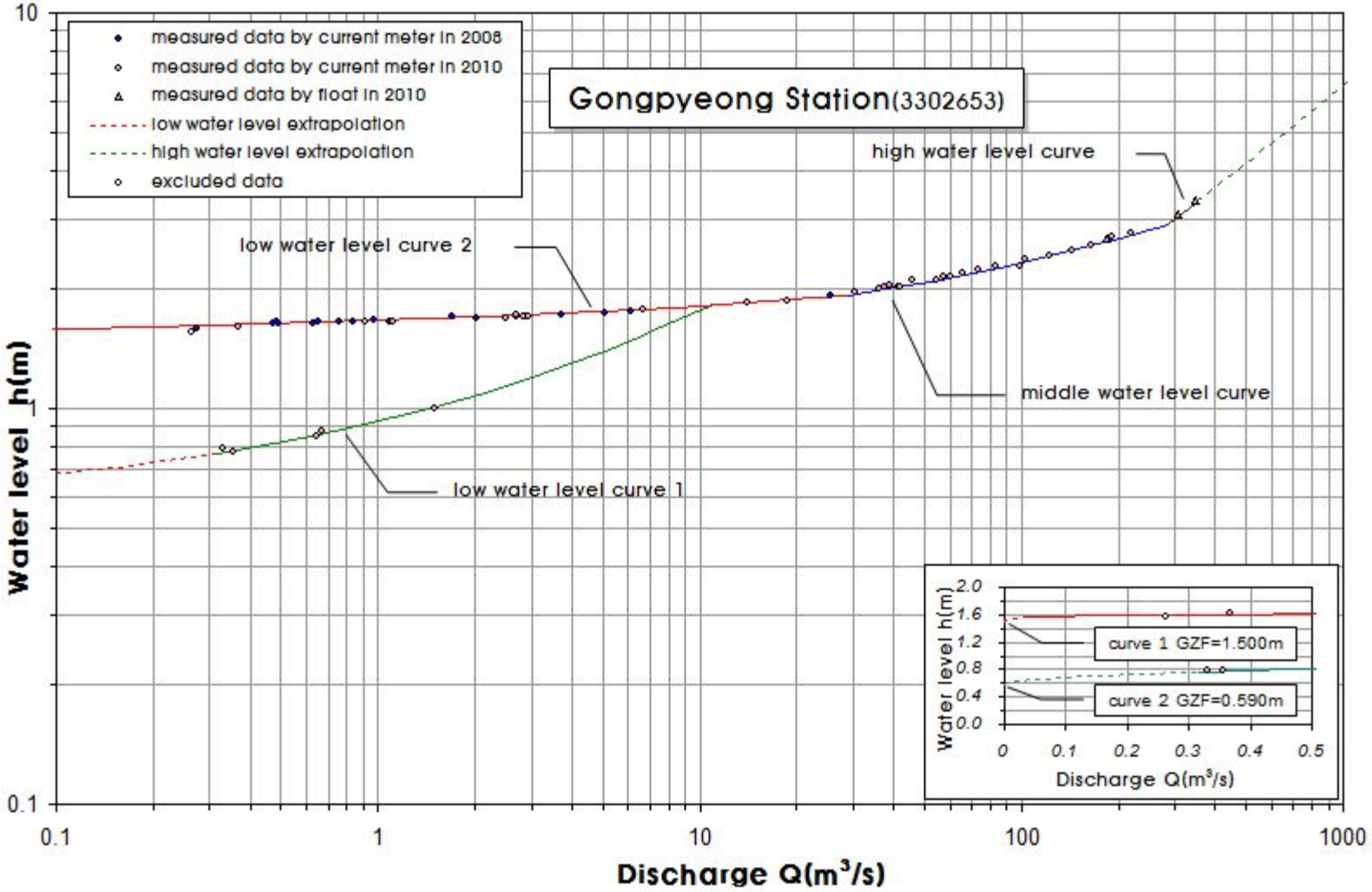
Case analysis with various field conditions

- **Development of rating curve in backwater effect (Weir, Stream juction)**
- Example of **Weir operation**
  - Field monitoring case of weir operation



Case analysis with various field conditions

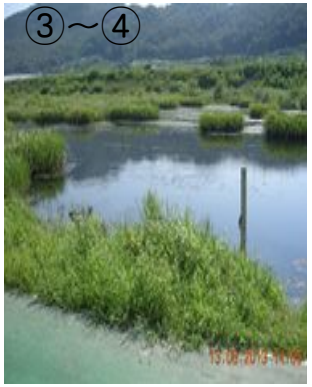
- **Development of rating curve in backwater effect (Weir, Stream juction)**
- Example of **Weir operation**



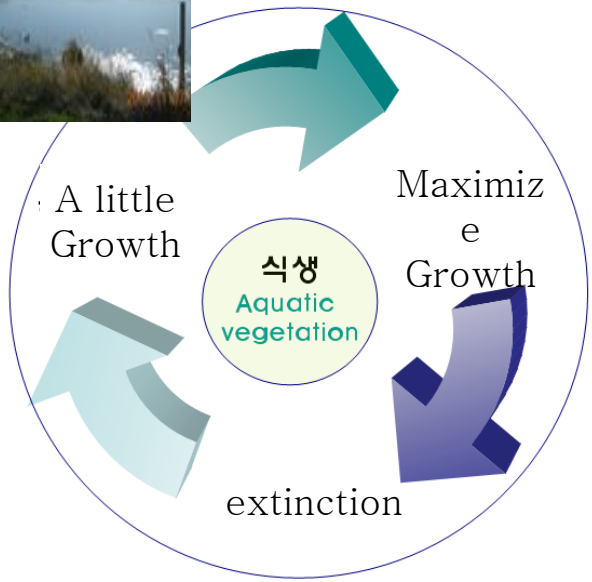
Case analysis with various field conditions

- **Development of rating curve Considering Vegetation**
- Example according to the monitoring of vegetation growth and development of rating curve by vegetation.

  - Separation of period by growth(Circulation) of vegetation



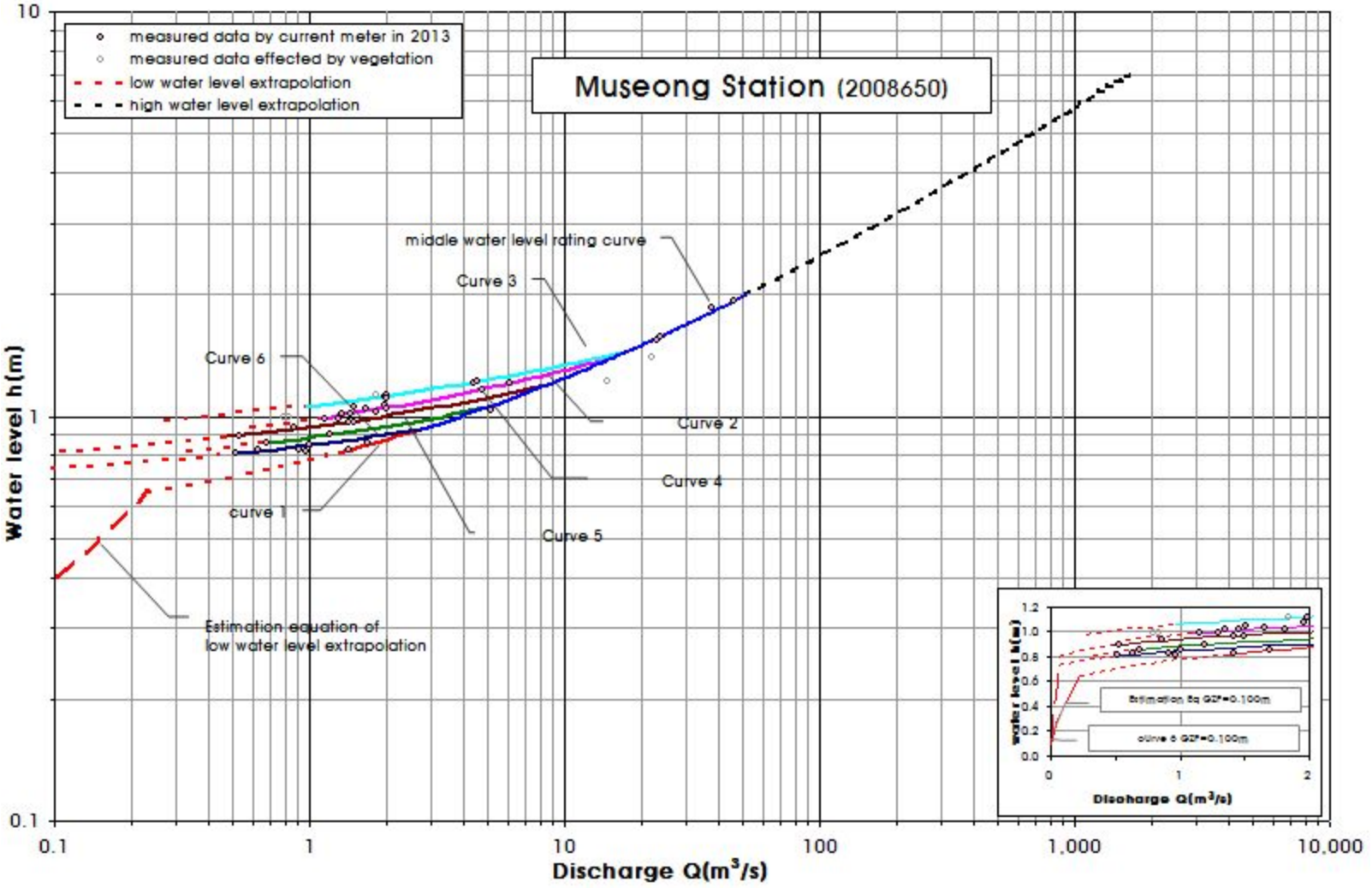
① Little effect of Vegetation
②~④ The growth period of vegetation
⑤~⑦ The extinction period of vegetation



Periodicity of vegetation

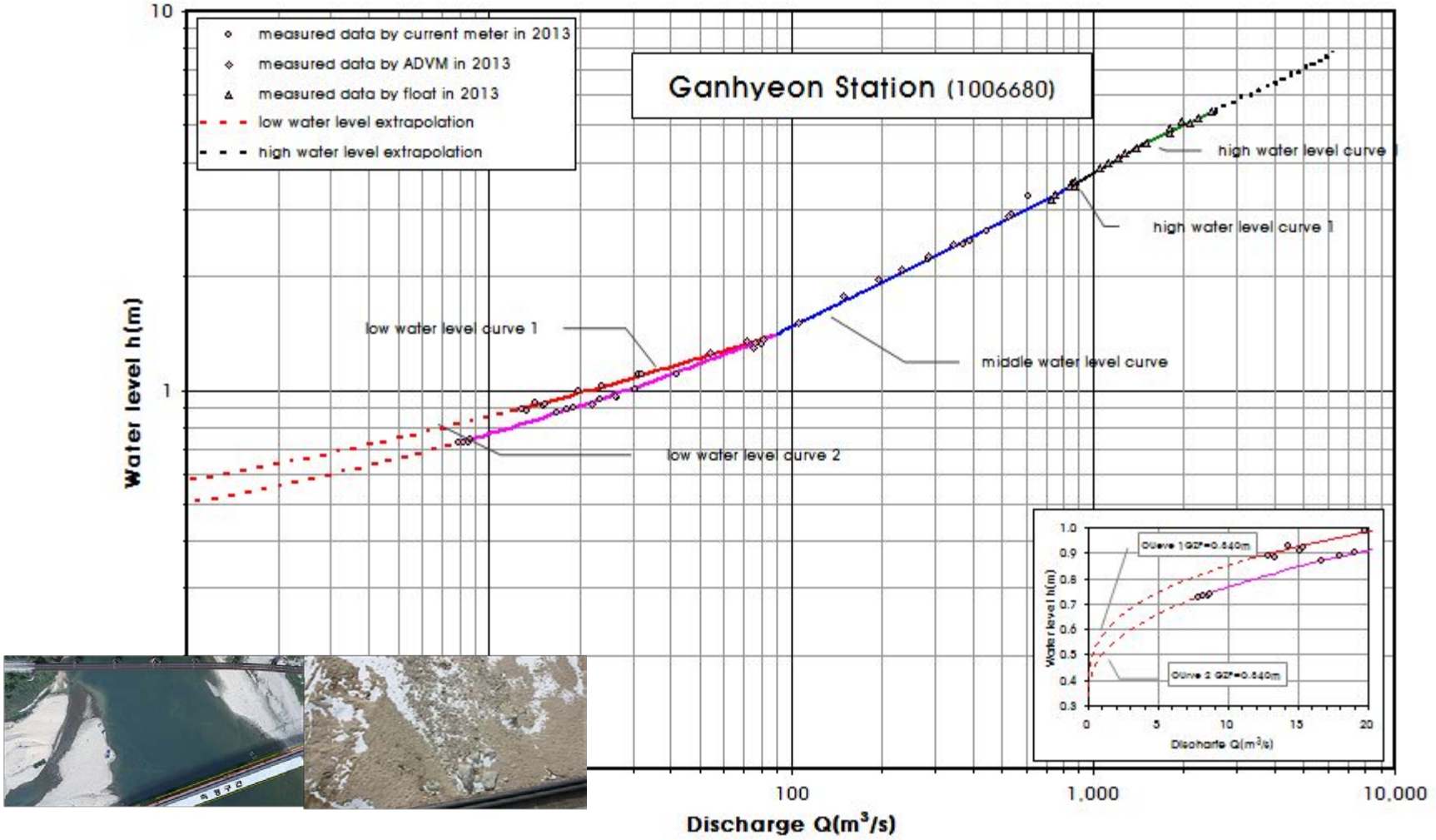
Case analysis with various field conditions

- **Development of rating curve Considering Vegetation**
- Example according to the monitoring of vegetation growth and development of rating curve by vegetation.



Case analysis with various field conditions

- **Analysis on effect of stream environment change on rating curve**
- Example of sand channel stream (Separation by before and after the flood bed change)
- ①13/01/01 00:00-13/07/20 18:40 ②13/07/20 18:50-13/12/31 23:50 (Scour of session)



Work Plan

Modification of work plan

- 'Writing technical report ' for each activities moved from action plan to outcomes

→ Providing technical reports as outcome of each action, including results from review on collected information and case study for three parts

- The details of case study for each action were add to the activities

→ Providing technical information and guidance on adequate application of instrument, proper measurement or data analysis and those procedure, for various conditions

- By above modifications, milestones were changed partly

Work Plan

Modification of work plan_1. IRDIMS (Before)

Deliverables	Activities	Outputs	Resources	Milestones	Linkages
2. Hydrometric measurements with quality and accuracy (2.2.2)	a) Provide guidance on the use of appropriate instruments and methods of observation in diverse conditions (Priority A) - Collection of the existing technical information of IRDIMS - Collection of construction, measurement cases and management of IRDIMS(More 52 sites) - Writing Technical report about construction and management by field characteristics	-Provide Technical report and guideline to design, install and operate of facilities of Integrated Real-time Discharge measurement system(IRDIMS) -Software System and manual for data QC and evaluation of IRDIMS	-Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016 - Collection of the existing technical information of IRDIMS by June 2015 -Collection of construction, measurement cases and management of IRDIMS (More 52 sites) by Dec 2015 -Writing Technical report about construction and management by field characteristics by Dec 2016	- CHy - ROK

Work Plan

Modification of work plan_1. IRDIMS (After)

Activities	Actions	Outputs	Resources	Milestones	Linkages
2. Hydrometric measurements with quality and accuracy (2.2.2)	a) Provide guidance on the use of appropriate instruments and methods of observation in diverse conditions (Priority A) - Collection of the existing technical information of IRDIMS • Measurement instrument(ADVM) • Methods of discharge calculation • Construction and operation of IRDIMS - Case study on measurement of IRDIMS(52 sites) • Measurement in tidally effected area • Measurement in backwater effected area caused by weir, sluice gate, junction • Evaluation of measurement results • Development of index rating	-Technical report and guideline to design, install and operate of facilities of Integrated Real-time Discharge measurement system(IRDIMS) -Software for Index rating developing procedure	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016 - Collection of the existing technical information of IRDIMS by Dec 2015 - Case study on measurement of IRDIMS(52 sites) by Jun 2016	- CHy - ROK

Work Plan

Modification of work plan_2.Sediment (Before)

Deliverables	Activities	Outputs	Resources	Milestones	Linkages
	b)Improve sediment measuring techniques (Priority B) - Collection of the existing technical information -Collection of measurement case(20-50 sites) -Writing Technical report about sediment measurement method and analysis of field characteristics	- Technical report for sediment measurement	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016	- CHy - ROK

Work Plan

Modification of work plan_2.Sediment (After)

Activities	Actions	Outputs	Resources	Milestones	Linkages
	b)Improve sediment measuring techniques (Priority B) - Collection of the existing technical information • The status of existing sediment measurement technique • The status of development of new technology and its applications • The status of analysis methods - Case study on sediment measurement in various conditions (15-20 sites) • Analysis on characteristics of sediment load in rising and falling water level(Loop) • Analysis on river construction effect on characteristics of sediment load, focused on 4major river project in Korea • A comparative analysis on sediment load by sequence of rainfall event.	- Technical report for sediment measurement	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016	- CHy - ROK

Work Plan

Modification of work plan_3. Rating (Before)

Deliverables	Activities	Outputs	Resources	Milestones	Linkages
3. Calculation of runoff with quality and accuracy (2.2.3)	a) Focus on the development of rating curve - Collection of the existing technical information (Priority B) -Arrangement of theory for development rating curve -Case analysis with field condition (weir, tidal, backwater, vegetation etc.) ~~- Writing Technical of characteristics~~	-Report on methods to develop rating curves	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016	- *CHy* - ROK

Work Plan

Modification of work plan_3. Rating (After)

Activities	Actions	Outputs	Resources	Milestones	Linkages
3. Calculation of runoff with quality and accuracy (2.2.3)	a) Focus on the development of rating curve(Priority B) - Collection of the existing technical information • The major procedure for development of rating curve • Development tool of rating Curve - Case analysis with various field conditions • Development of rating curve by backwater effect (weir, backwater of main stream and branch) • Guideline for development of rating curve considering vegetation • Reviewing the rating curve change according to changes of stream environment	- Technical report for rating curve development	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016	- CHy - ROK

Thank you for your attention!