Mekong River Commission

Japan International Cooperation Agency

# THE STUDY ON HYDRO-METEOROLOGICAL MONITORING FOR WATER QUANTITY RULES IN MEKONG RIVER BASIN

## FINAL REPORT

## VOLUME II SUPPORTING REPORT (1/2)

**March 2024**

**CTI Engineering International Co., Ltd.**

**NIPPON KOEI Co., Ltd.**

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*Japan International Cooperation Agency*

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# VOLUME II

# PAPER I

# IMPROVEMENT OF HYDROLOGICAL STATIONS

# <u>FINAL REPORT</u>

**MARCH 2004**

**WUP-JICA TEAM**

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# 1. INVENTORY SURVEY OF HYDROLOGICAL STATIONS

The inventory survey of hydrological stations has been carried out in order to understand their operating conditions. An inventory survey was not made for the meteorological stations like the rainfall stations, because there are no significant differences of hydrological and meteorological stations from the topographic and geomorphologic points of view.

The survey covered all stations along the Mekong, Tonle Sap and Bassac rivers and the Mekong Delta distributaries, and the key network stations along the major tributaries. The total number of stations surveyed was 60 as shown in Table 1.1. The schematic diagram of stations is shown in Fig. 1.1.

**Table 1.1 Hydrological Stations for Inventory Survey**

| River System | Network Classification | Number | Note (River Name) |
|---|---|---|---|
| Mekong | Key | 13 | |
| | Primary | 8 | |
| | Basic | 10 | |
| Tonle Sap | Key | 2 | |
| | Primary | 1 | |
| | Basic | 1 | |
| Bassac | Key | 3 | |
| | Primary | - | |
| | Basic | 4 | |
| Mekong Delta Distributaries | Key | 2 | Co Chien, Ham Luong, Nam Nao, Cua Dai, Cua Tieu |
| | Primary | 8 | |
| | Basic | 3 | |
| Major Tributaries | Key | 5 | Nam Mun, Nam Ngum, Nam Ca Dinh, Se Ban Hiang, Se San |
| | Total | 60 | |

**Table 1.2 Hydrological Stations per Country**

| Country | Thailand | Lao PDR | Cambodia | Vietnam | Total |
|---|---|---|---|---|---|
| Number | 16 | 13 | 13 | 18 | 60 |

The inventory sheets prepared by the WUP-JICA Team contain the following survey items:

- Fundamental information (Country, River Name, Network Classification, Station Code and Name, Drainage Area)
- Location (Latitude, Longitude)
- Zero of gauge elevation and datum
- Extremes (Maximum, Minimum)
- Responsible organization
- Observed parameter and period
- Type of gauge and recorder, data storage media

- Frequency of observation
- Observer
- Data transmission and processing
- Issues in observation
- Map and photo

The inventory survey was made in close collaboration with the line agencies concerned during the second field survey period from May to August 2001. These line agencies are:

| | |
|---|---|
| Thailand: | Department of Energy Development and Promotion (DEDP), which was reorganized into the Department of Water Resources (DWR) in October 2002 |
| Lao PDR: | Waterways Administration Division (WAD), Department of Meteorology and Hydrology (DMH) |
| Cambodia: | Department of Hydrology and River Works (DHRW) |
| Vietnam: | Southern Region Hydro-Meteorological Centre (SRHMC) |

The results of the inventory survey are given in the Data Book prepared for submission in January 2004.

# 2. IMPROVEMENT OF HYDROLOGICAL STATIONS

The hydrological network stations in the Lower Mekong Basin (LMB) have been classified into four (4) classes according to the importance of location, stability, and reliability of recorded data; namely, Key, Primary, Basic and Local stations. Since fifteen (15) stations out of the 25 key network stations are to be improved into a telemetry system with assistance provided by AHNIP (Australia), the WUP-JICA Team selected the remaining 10 key network stations as the initial number of hydrological stations for improvement.

## 2.1 Site Inspection

Site inspections have been made on the ten (10) hydrological stations selected for improvement to clarify their site conditions, and consultations with the line agencies concerned were later made on the necessity and items for further improvement. The 10 stations inspected were as follows:

**Table 2.1 Hydrological Stations Inspected**

| No. | Station (River) | Country | Date |
|---|---|---|---|
| 1 | **Ubon** (Nam Mun) | Thailand | July 27, 2001 |
| 2 | **Pak Kagunung** (Num Ngum) | Lao PDR | June 29, 2001 |
| 3 | **Ban Phonesy** (Nam Cading) | | June 29, 2001 |
| 4 | **Ban Keng Done** (Se Bang Hieng) | | June 30, 2001 |
| 5 | **Ban Komphoun** (Se san) | Cambodia | July 24, 2001 |
| 6 | **Kompong Cham** (Mekong) | | May 29, 2001 |
| 7 | **Chak Tomuk** (Bassac) | | July 18, 2001 |
| 8 | **Neak Luong** (Mekong) | | May 29, 2001 |
| 9 | **Can Tho** (Bassac) | Vietnam | July 11, 2001 |
| 10 | **My Thuan** (Mekong) | | July 11, 2001 |

## 2.2 Screening of Stations and Planned Improvement Works

The screening of stations was made, based on the results of site inspections and the discussions with the line agencies concerned. Through the discussion with DHRW (Cambodia), the Cham Tangoy (Se Kong) station was recommended for additional improvement because this station is located in a major tributary. Ban Komphoun (Se San) was as well recommended.

As for the measuring equipment, the WUP-JICA Team proposed in its Working Paper (1) that a pressure-transducer sensor should be installed at each station to be improved. However, as the result of discussion with the Mekong River Commission Secretariat (MRCS), the WUP-JICA Team adopted the gas-purged sensor in consideration of its advantage against heavy siltation.

The stations to be improved, as well as their operating conditions and planned improvement works are as discussed below and summarized in Table 2.2. The location of each station is indicated in Fig. 2.1.

## (1) Thailand (DWR, formerly DEDP)

**Ubon Station in Nam Mun**

Ubon Station is located under the Saereprachatippatai Bridge. It has been equipped with vertical staff gauges that were maintained in good condition. The improvement works for this station included the installation of a set of gas-purged sensor and data logger. As for the related civil works, two alternatives were proposed, as follows:

(a) Installation of a galvanized pipe along the downstream side of the bridge pier and an instrument box with pole on the bridge handrail.

(b) Installation of a galvanized pipe along the left bank and an instrument box with pole at the corner of the parking space.

## (2) Lao PDR (WAD and DMH)

**Pak Kagnung Station in Nam Ngum (DMH)**

Pak Kagnung Station has been equipped with vertical staff gauges. No stairway has been constructed. The necessary improvement works were the construction of a slope gauge and stairway for safer observation, and the installation of a set of gas-purged sensor and data logger. Gabion mattress or cylinder was to be installed at both sides of the slope gauge and stairway for protection against scouring.

**Ban Phonesy Station in Nam Cading (DMH)**

Ban Phonesy Station has been selected for improvement instead of the Damsite Station, because it was found from the hearing survey with DMH that the Damsite Station was a temporary station. Ban Phonesy station is located in the downstream of the Damsite station.

The slope gauge and stairway constructed in the late 1990s under the JICA Grassroots Project were still in good condition. A gas-purged sensor with its measuring tube inside a galvanized pipe was to be installed along the slope gauge, and the data logger has to be accommodated in the instrument box at the bank.

**Ban Keng Done Station in Se Bang Hiang (WAD)**

Gas purged sensor and data logger were installed at the station in 1999 by the project of Improvement of the Hydro-Meteorological Network, Component II that was funded by the Government of Australia. However, no stairway was constructed for slope gauge reading. The installation of stairway and renewal of slope gauge were requested by WAD, and gabion mattress or cylinder was to be installed at both sides of the slope gauge and stairway for protection against scouring.

## (3) Cambodia (DHRW)

**Ban Komphoun Station in Se San**

The station has been equipped with only vertical staff gauges. The necessary improvement works were the construction of slope gauge and stairway for safer observation, and the installation of a set of gas purged sensor and data logger. Gabion mattress or cylinder has to be installed at both sides of the slope gauge and stairway for protection against scouring.

**Cham Tangoy Station in Se Kong**

This station has been recommended for improvement by DHRW. The site inspection and discussion were made at the same time with Ban Komphoun Station (Se San).

The station also has been equipped with only vertical staff gauges. The necessary improvement works were the construction/installation of slope gauge, stairway and gabion mattress or cylinder for bank protection, and the installation of a set of gas purged sensor and data logger.

**Kompong Cham Station in Mekong**

Gas purged sensor and data logger has recently been installed at the station under an Australian-assisted project. They were still functioning well, and the slope gauge and stairway were also in good condition. Thus the WUP-JICA Team had determined through the onsite discussion with DHRW that further improvement works were not necessary.

**Chak Tomuk Station in Mekong/Tonle Sap**

The slope gauge and stairway, which are located at the bank behind the National Convention Centre, were in good condition. Gas purged sensor with its measuring tube inside a galvanized pipe have to be installed along the stairway, and the data logger should be accommodated in the instrument box at the bank.

**Neak Luong Station in Mekong**

Float type recorder and stilling well had been installed at the station. However, the recorder and relevant facilities have much deteriorated so that restoration works on the station were requested by DHRW. In addition, gabion mattress should be installed around the well, and a set of gas purged sensor and data logger should also be installed.

### (4) Vietnam (SRMHC)

**Can Tho Station in Bassac**

At Can Tho Station, installed were the float type recorder, gas purged sensor and data logger, and vertical staff gauges. The facilities and equipment were in good condition. Thus the WUP-JICA Team had determined through the onsite discussion with SRHMC that further improvement works were not necessary.

**My Thuan Station in Mekong**

At present, this station is equipped with only vertical staff gauges. SRMHC planned in 2002 to relocate the station one kilometre upstream of the original site. The newly planned My Thuan Station was to be equipped with a float type recorder and staff gauges. In addition to this, the WUP-JICA Team also planned to install a set of gas purged sensor and data logger at the new station.

## 2.3 Design and Related Documents for the Improvement of Hydrological Stations

The WUP-JICA Team had prepared the general design in the technical specification of the proposed works. The general design takes the following items into consideration:

- The construction locations shall be the same as those of the existing stations.
- Basically, gabion mattress or cylinder shall be installed around the facilities for protection against scouring.
- The gradient of slope gauge shall follow the present riverbank gradient.

The general designs of slope gauge type and float type are shown in Fig. 2.2.

The technical specification prepared for each riparian country does not stipulate the installation of measuring equipment because it has been excluded from the improvement works. The WUP-JICA Team, in cooperation with the line agencies, carried out the installation of the equipment within June to October 2002.

The technical specifications included the following:

- Location and general drawing of station
- Elevation of zero-gauge-reading, range of observation
- Structural drawings and approximate size

Regarding detailed construction locations, the Team and representatives of the line agencies had decided them onsite. Detailed construction drawings have been prepared by local contractors in accordance with the technical specifications and based on the site inspections. The elevation of zero gauge and range of observation also were decided by the Team in coordination with the line agencies. Basically the elevations and ranges of observation followed the previous values and ranges. As for Neak Luong Station, however, the maximum range was raised by 1 meter from the previous one because the water level of the flood in 2000 had reached the approach bridge.

In addition to the technical specifications, the Team had prepared the conditions of engagement. In the documents prepared, the Cost of Services, Method of Payment, Force Majeure, Time Schedule, etc., have been stipulated.

## 2.4 Implementation of Improvement Works

Improvement works, including the related civil works and the installation of equipment started at the beginning of 2002 and were completed within the schedule shown in Fig. 2.3. As for Vietnam, however, the relocation of My Thuan Station was delayed so that the SRMHC in Ho Chi Minh City is storing the equipment until the new station is constructed.

All measuring equipment, consisting of OTT Nimbus gas-purged sensors and data loggers, were procured in Japan and shipped to each country through MRC in between July and November 2002. The schedule of delivery to the line agencies had varied greatly depending on the facility of acquiring a customs clearance in each country.

During the installation of equipment, the WUP-JICA Team conducted training for the line agencies in the aspect of operation and maintenance. The schedules of installation of equipment and training are also shown in Fig. 2.3.

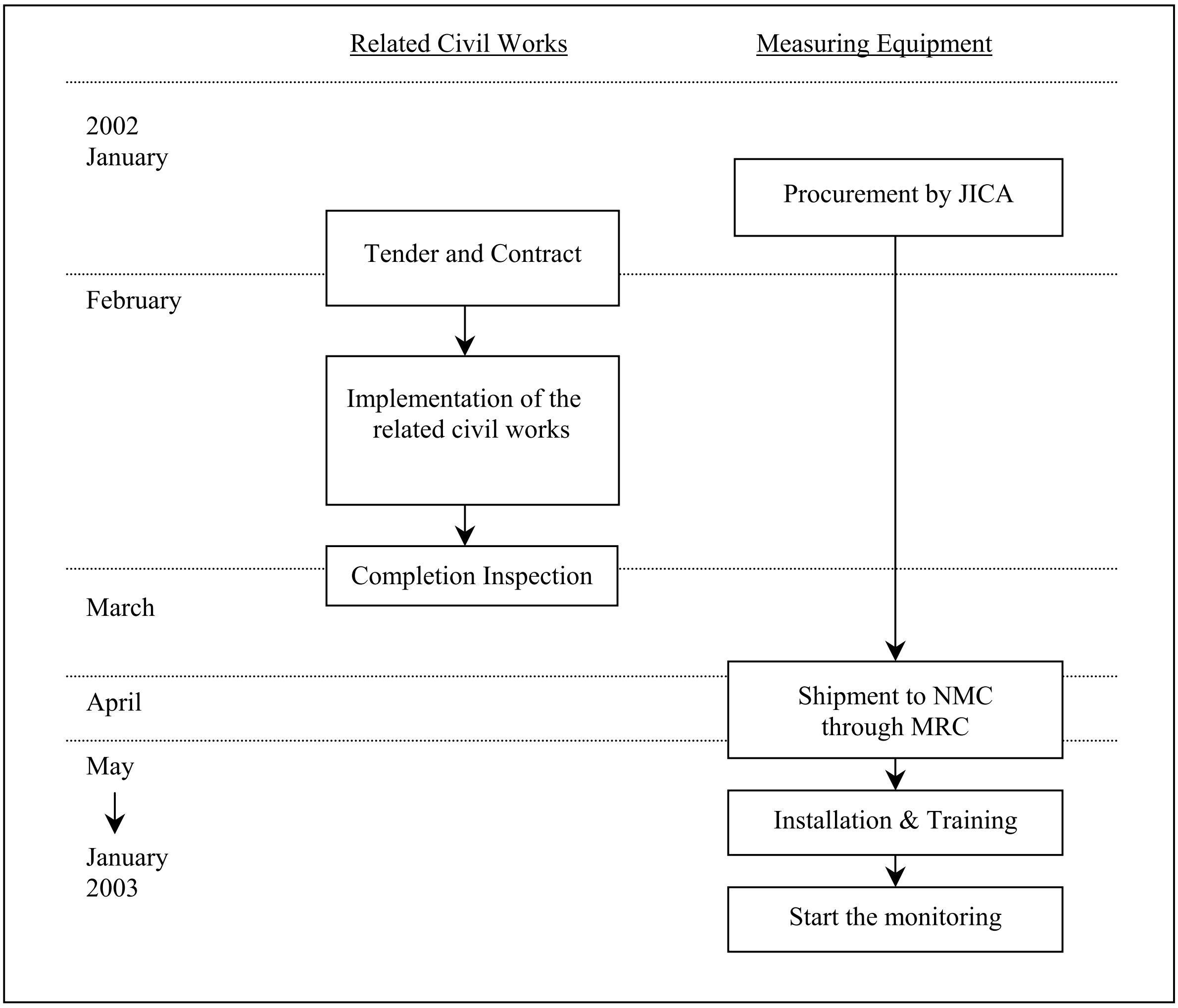



**Fig. 2.3 General Schedule**

The improvement work in each MRC member country was divided into three (3) stages; construction work, installation of equipment, and training on handling the equipment. The work at each country is as outlined below.

## (1) Thailand

The start of construction work in Thailand was behind schedule, because it took a long time for TNMC and the WUP-JICA Team to reach a consensus on the TOR. The improvement work was started only in June 2002.

### (a) Construction Work

The local contractor completed the construction works at Ubon during June to August 2002. The construction works consisted of the installation of galvanized steel pipe along the downstream side of the pier and the instrument box with pillar to the bridge. The completion inspection was carried out on 14 August 2002.

### (b) Installation of Equipment

The measuring equipment procured in Japan were shipped to the JICA Cambodia Office and finally delivered to the Hydrological Centre of the Department of Water

Resources (DWR, formerly DEDP) in Ubon through the MRC in August 2002. The WUP-JICA Team in cooperation with the line agency and the local contractor implemented the installation of measuring equipment on 14 August 2002.

At the end of the 2002 flood season, however, the bottom support of the pipe was washed away so that the pipe was reinstalled temporarily. The pipe will be reinstalled again in the next low flow season with protection.

#### (c) Training on the Operation of Nimbus and HYDRAS 3 Software

The training was held on 16 January 2003 at the Hydrological Centre in Ubon. The indoor training, containing the principle and procedure of measurement and the communication and operation of Nimbus using the HYDRAS 3 software was held in the morning. The OJT at the site for configuring the Nimbus and downloading the data was conducted in the afternoon.

### (2) Lao PDR

There were three (3) target stations at which slope gauges were installed. The works were commenced and completed on schedule.

#### (a) Construction Work

The civil and construction works were completed by the local contractor in the 2002 dry season (January to March). Gabion mattresses were installed around the facilities for protection against scouring, except for the Ban Phonesy Station, which is located on a firm base.

#### (b) Installation of Equipment

The responsible agency, DMH, received the measuring equipment from MRC in August 2002. However, the installation was delayed on account of the study schedule. The installation of equipment was finally carried out by DMH staffs and the WUP-JICA Team on October 28 and October 29, 2002 for Pak Kagnung Station and Ban Phonesy Station respectively.

As for Pak Kagnung Station, the end of the measuring tube was found to be buried in sediment at the time of equipment installation. This was because nobody had taken cared of the station after the completion of installation of the tube. Thus, the end of measuring tube (pipe) was reinstalled at the end of December 2002.

#### (c) Training on the Operation of Nimbus and HYDRAS 3 Software

Indoor training for the operation of Nimbus was held on 30 October2002 at the DMH office. The principle and procedure of the measurement, and how to communicate and operate Nimbus using HYDRAS 3 software were explained in this training. In future, the training on downloading and processing of data will be conducted actually using raw data.

### (3) Cambodia

There were four (4) target stations, consisting of three (3) slope gauge type and one (1) stilling well type. The improvement works have been undertaken on schedule.

#### (a) Construction Work

The civil and construction works were completed by the local contractor in the 2002 dry season (January to March). The slope gauge type of station was adopted for the Ban Komphoun, Cham Tangoy and Chak Tomuk stations, while it was stilling well type for Neak Luong station in consideration of the shape of the bank and the former station type. Gabion mattress was installed around the facilities for protection against scouring, except for Chak Tomuk station, which is located on a concrete embankment.

#### (b) Installation of Equipment

The measuring equipment procured in Japan was shipped to Cambodia, and the WUP-JICA Team received them from the JICA Cambodia Office on 23 May 2002. The measuring equipment for each station was installed by DHRW and the Team during June to July 2002.

#### (c) Training on the Operation of Nimbus and HYDRAS 3 Software

The responsible agency, DHRW, had already installed Nimbus in some stations and its staffs are already familiar with the operation. Hence the WUP-JICA Team agreed to the proposal of DHRW that training was not necessary for their staff.

### (4) Vietnam

As mentioned before, the relocation of My Thuan Station has been delayed and construction of the new stations is still ongoing.

The measuring equipment procured from Japan was delivered to the SRMHC in November 2002. The SRMHC will take custody of the equipment until the completion of relocation. To date, therefore, the installation of measuring equipment has not yet been carried out.

## 2.5 Present Condition of Improved Equipment

To check the present operating condition of installed equipment, the data measured by Nimbus were inspected to compare them with the manual reading.

**Thailand**

**Ubon Station**: Nimbus has been installed at the station and measurement was started on 15 August 2002. For a while after the installation, the Nimbus data in the middle range (4.0 to 8.0m) fitted with the manual reading data. When it was over 8.0m in gauge height, however, the fluctuation and the gap between the manual reading value became remarkable and wider until it reached approximately 20cm. At the falling stage and lower than 10m in gauge height, the Nimbus data fit again with the manual data.

On 29 October 2002 during the 2002 flood season, the base supporting the measuring tube was washed away. Comparing the measurement results with those before the base was washed away, there may have been some problem with the fixing of the tube outlet because when the water level exceeded 8m in gauge height, the gap and fluctuation became suddenly remarkable. It seems that the fixing of the bottom parts were loosened by debris, moved by the current, and then finally washed away.

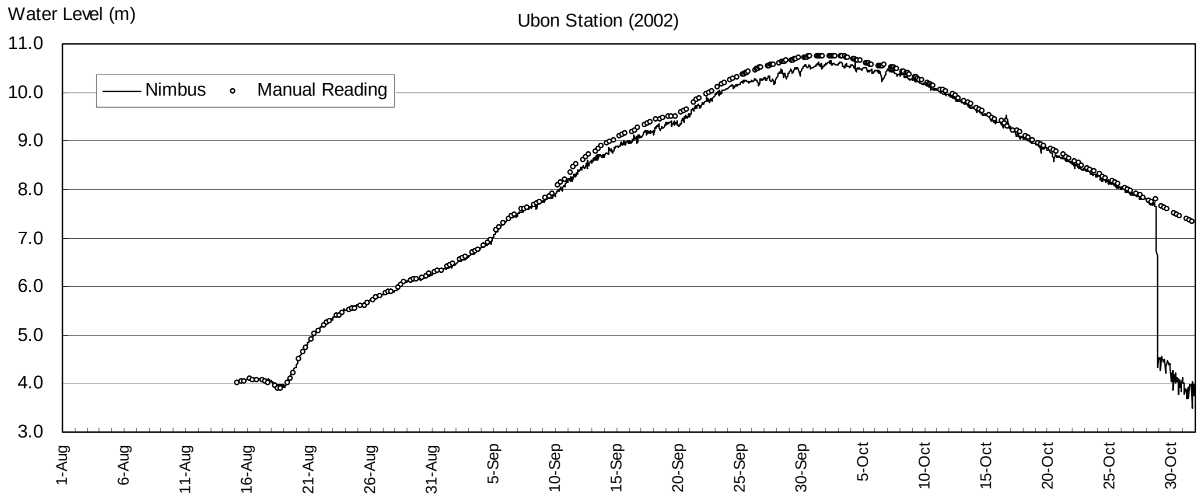



**Fig. 2.4(1/2) Measured Data of Ubon Station**

Thereafter, staffs of DWR repaired the loosened end of the measuring tube by themselves in accordance with the advice of the WUP-JICA Team at the end of April 2003. The following figure shows the measurement just after the reinstallation of bottom parts at the end of 2003.

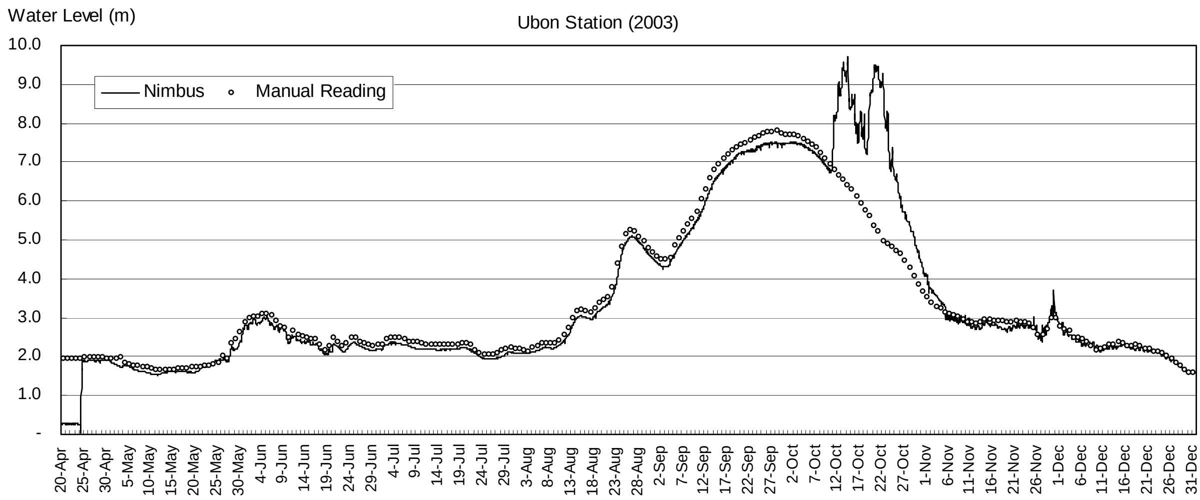



**Fig. 2.4(2/2) Measured Data of Ubon Station**

In the middle of October up to the beginning of November 2003, the Nimbus data was plotted as remarkably different from the manual reading data. The cause may be the choking of the outlet of the measuring tube with sediment or debris. Thereafter, the Nimbus data gradually turned to be in agreement with the manual reading because the obstruction may have been washed away naturally.

In fact, the adjustment of water level in Nimbus at the reinstallation was omitted. Then, during the site inspection in January 2004, all Nimbus data in the figure were deducted from the difference of water level between manual reading and Nimbus data. Although Nimbus data were plotted somewhat below the manual reading data, totally, Nimbus data were plotted almost on manual reading data except the period from the middle of October to the beginning of November 2003.

## Lao PDR

**Pak Kagnung Station**: As aforesaid, the sediment problem at the outlet of measuring tube happened right after the equipment installation in 2002. The sedimentation had resulted from the cofferdam where wooden piles were installed for the construction of the gauging station and they were not completely removed. After the executing agency, DMH, removed the cofferdam and wooden piles around the bottom of the gauging station in the 2003 low flow season, the sediment was washed away and the problem was settled.

However, parts of the power supply encountered some trouble in July 2003. The WUP-JICA Team brought it back to Japan for repair in August 2003. In September 2003, the parts were reinstalled by the Team and the DMH staff and the equipment has been functioning well since then. The Team expects that highly accurate data will accumulate in the future

**Ban Phonesy Station**: The following figure was recorded right after the installation of measuring equipment in 2002 up to the end of April 2003. The verification by comparison with the manual reading data has been impossible because the manual reading data could not be obtained.

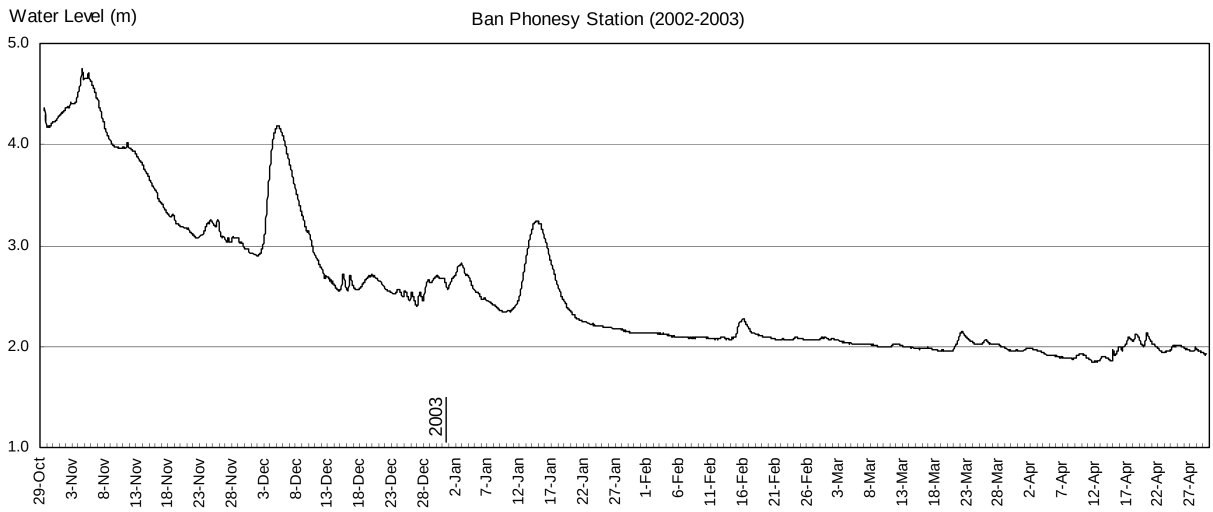



**Fig. 2.5 Measured Data of Ban Phonesy Station**

As can be seen from this figure, the measuring equipment of this station has been functioning well because there are no missing and abnormal data. The equipment had functioned well at the time of site inspection in September 2003 as well. However, the value of Nimbus had been readjusted at the time because there were small gaps between the water level of the manual gauge and the equipment. Unfortunately, the latest data has not yet been obtained.

## Cambodia

**Ban Komphoun Station**: From right after the installation of equipment until the end of 2002, Nimbus data were in agreement with manual reading data very well in the whole range of water levels. However the gaps between them gradually grew bigger since the end of 2002. By readjusting the water level in Nimbus on 10 February 2003, the Nimbus data turned to be in agreement with the manual reading data again. After 3 months or when the water level went up suddenly, the Nimbus data was plotted somewhat below the manual reading data. This trend continued up to the latter half of 2003. These gaps would grow with the passage of time and the solution for these gaps is to check and adjust the value in Nimbus periodically if needed.

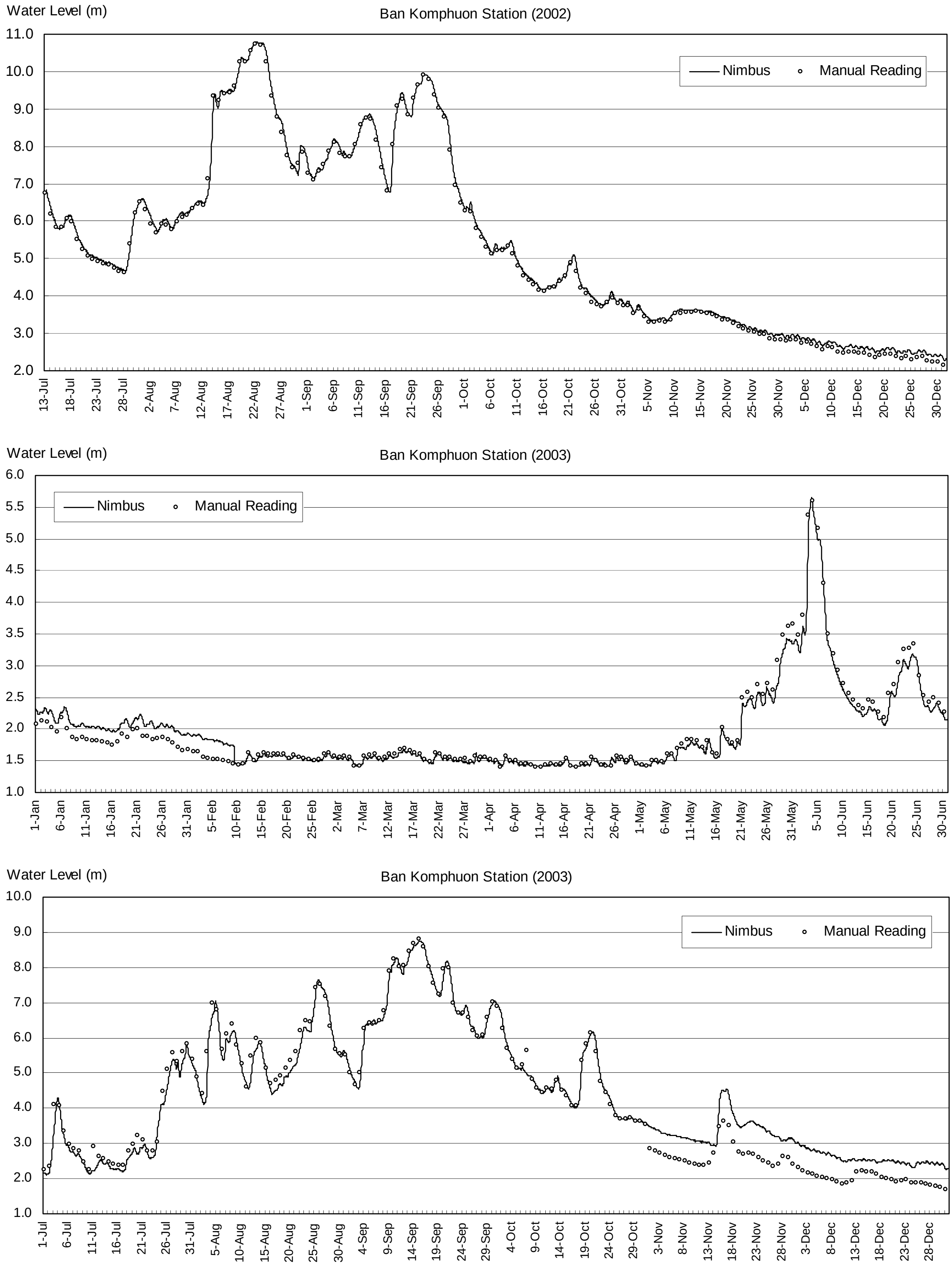
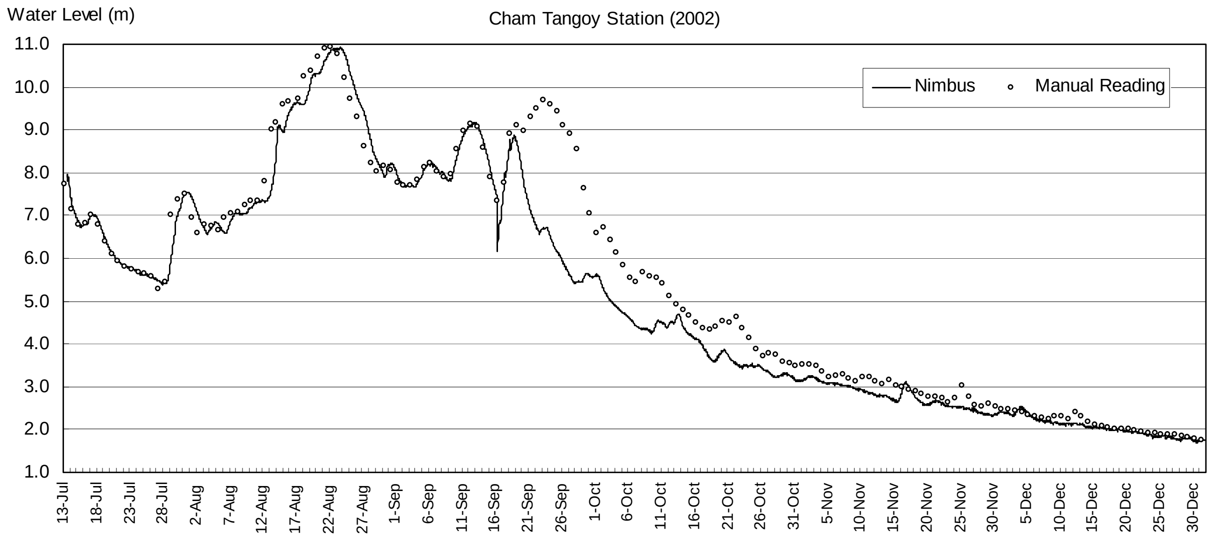



**Fig. 2.6 Measured Data of Ban Komphuon Station**

Large gaps constantly happened in November to December 2003. The cause might be different from the one mentioned above and it is not known exactly why. However, the manual reading data may have been misread because they lowered suddenly in the beginning of November, which is unnatural. Otherwise, the outlet of the measuring tube might be choked with sediment or debris. When the value in Nimbus is changed, the condition of the outlet of measuring tube should be checked.

**Cham Tangoy Station**: Right after the installation in July to the middle of September, the Nimbus data were almost plotted on the manual reading data. However, they separate widely after then, although the shape of each water level graph resembles closely. If the graph of Nimbus data after the peak between 16 and 21 September slides at around 1 October, Nimbus data would agree with manual reading data very well. Therefore, the gaps may be due to the miss-setting of the date of Nimbus.



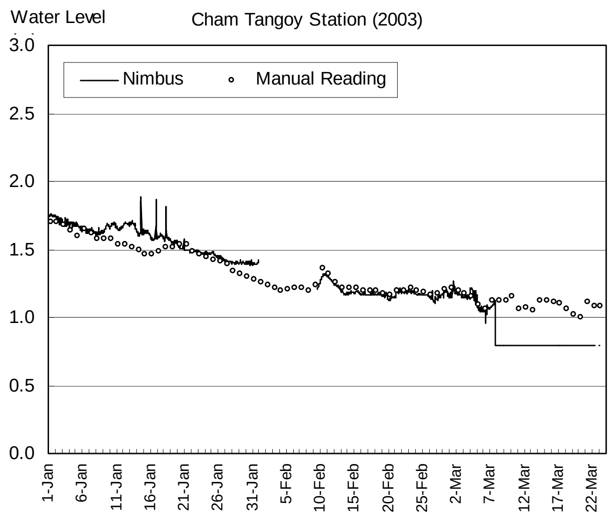




**Fig. 2.7 Measured Data of Cham Tangoy Station**

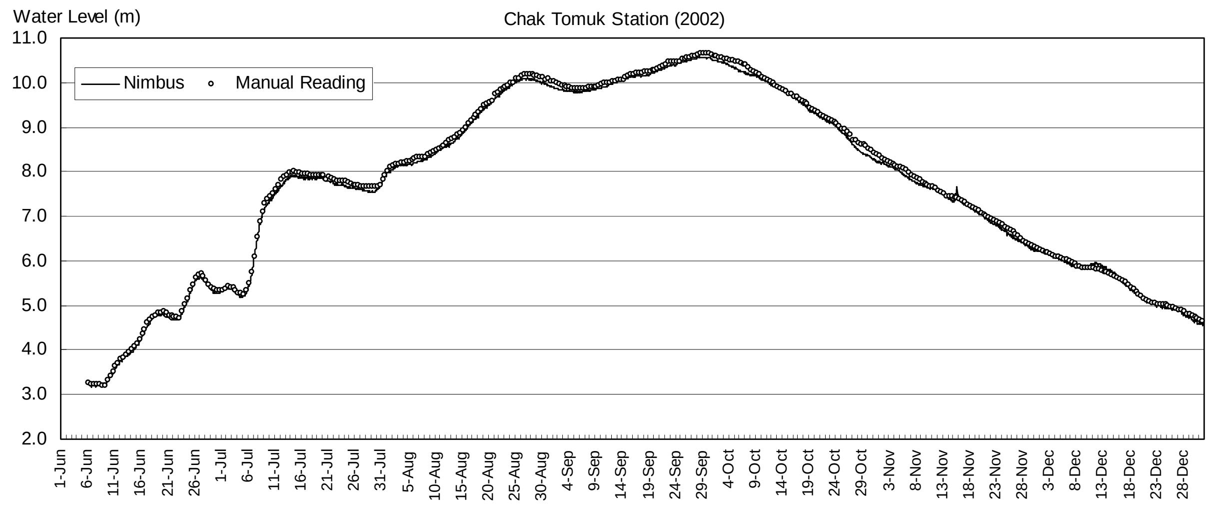
The abnormal and missing data happened after the middle of January 2003, and the measurement was finally stopped in March 2003. According to the interview with DHRW, the problem was found out during the site inspection of DHRW in August 2003. The detection was delayed because the opportunity for data collection is very limited. Cham Tangoy Station is located in Stun Treng Province, which is a long way off, almost 500 km, from Phnom Penh. The cause of stop of measurement is not known exactly. The sediment problem also happened once when the outlet was buried with sediment.

The WUP-JICA Team together with DHRW again conducted a site inspection in January 2004. At the time, Cham Tangoy Sation still has the sediment problem and the equipment had stopped functioning. Therefore, the location of outlet should be extended offshore and the sediment problem should be excluded in the next low flow season, March to April 2004 in cooperation with DHRW. As to the equipment problem, Nimbus was brought back to Phnom Penh, fixed and reinstalled again at the improvement of the station.

**Chak Tomuk station**: For six (6) months after the installation in June 2002, the Nimbus data were drawn almost on the manual reading data generally, although the Nimbus data tended to be plotted slightly below the manual reading data and there were gaps between them sometimes. One place in Nimbus data jumped in 13 to 18 November because the outlet of measuring tube may have been buried in sediment. When the pressure was raised, the sediment at one point was finally flashed away.

The general trend of the results in 2003 was almost the same as in 2002. However, there were two exceptional periods that show different trends, e.g., the Nimbus data rose but the manual data fell at around 21 January and 1 May respectively. The cause was not known clearly, but it might be the result of sediment influence as in the former case. Totally, the Nimbus data was in agreement with the manual reading value.

The fluctuations in the lowest are the tidal influence, but it is not so big such as Neak Luong station. According to the following figure, the measuring equipment has been functioning almost well.



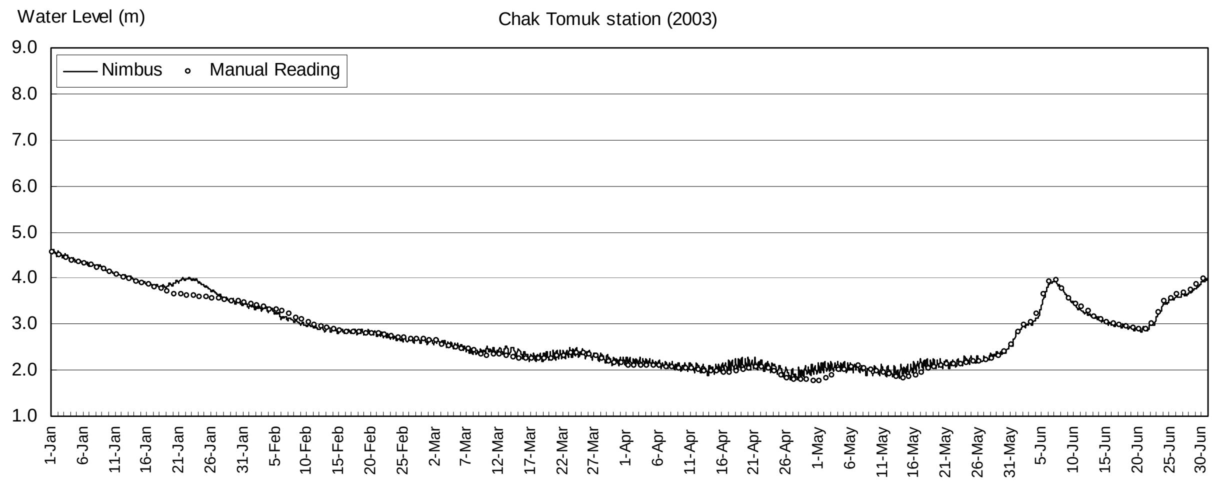




**Fig. 2.8(1/2) Measured Data of Chak Tomuk Station**

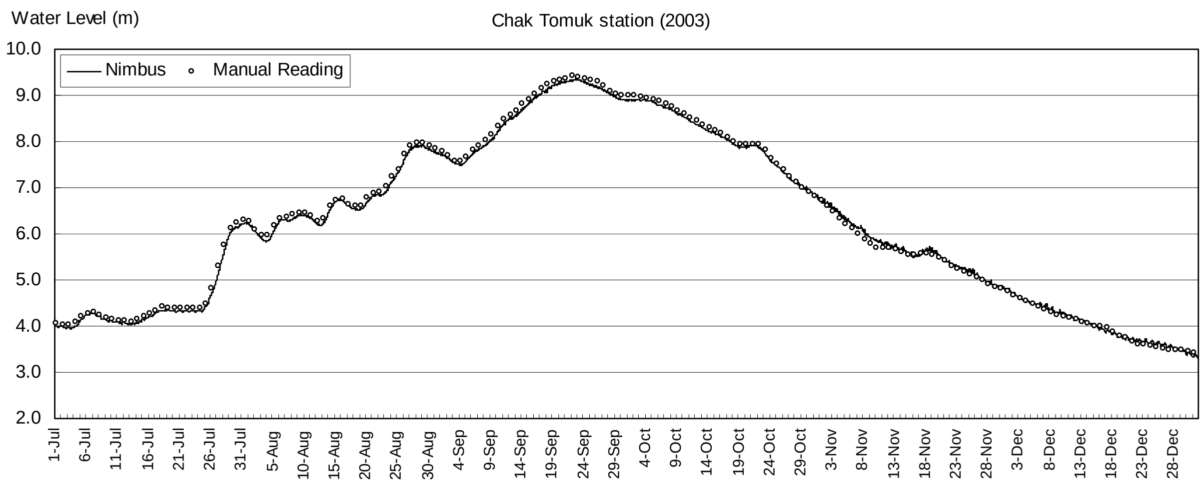



**Fig. 2.8(2/2) Measured Data of Chak Tomuk Station**

Chak Tomuk Station is highlighted because the elevation of zero gauge might have been incorrect. Usually, the difference of water levels between Chrui Changvar and Chak Tomuk are found to be 20 to 30cm. The difference should be around 0 because they are very closely located. In the WUP-JICA improvement work, the zero gauge was kept at the former value. Therefore, there are no gaps between before and after the improvement.

When the leveling survey was conducted by DHRW from the National Bench Mark in the Parliament to the TBM of the station in October 2003, the elevation of zero gauge was 0.232m and it was 1.3m higher than the former zero gauge, which is minus 1.02m. If the new value were assumed to be correct, the relation among the surrounding stations such as Chrui Changvar and Phnom Penh Port would be incoherent because the differences were found in only 20 to 30cm. The difference of 1.3m is too big. The situation of datum in Cambodia is now complicated. This issue should continue to be investigated after this study.

**Neak Luong Station**: Though Nimbus data were plotted somewhat below the manual reading data, the results have almost agreed with the manual reading data and have kept being stable for the six months after the installation in 2002. The constant gaps like this are easy to be modified by newly inputting correct water levels in Nimbus.

Regarding the Nimbus data in 2003, it has agreed with the manual reading value until the middle of February. After that, the Nimbus data was plotted somewhat above the manual reading value from the middle of February to April. Especially during April, the manual reading data were plotted below the bottom of fluctuation of Nimbus data. The gaps have grown up widely in this period. Thereafter, the Nimbus data turned to agree with the manual reading data for a while. This might be the result of sediment removal at the end of April 2003. However, the Nimbus data turned to be plotted below the manual reading data again as water level rose suddenly. When the water levels were falling, the Nimbus data were plotted somewhat above the manual reading data contrary to the water level rising. It appears that the response has been delayed.

The situation might have been caused again by sediment accumulation in the stilling well and the connecting pipe, i.e., the changes of river water level could hardly be reflected in the stilling well. As a result, the response was delayed.

The fluctuations in the low range were caused by tidal effect and came to about 60cm at most. As the water level exceeds 3m in gauge height, the fluctuation diminishes and the water level goes into being settled.

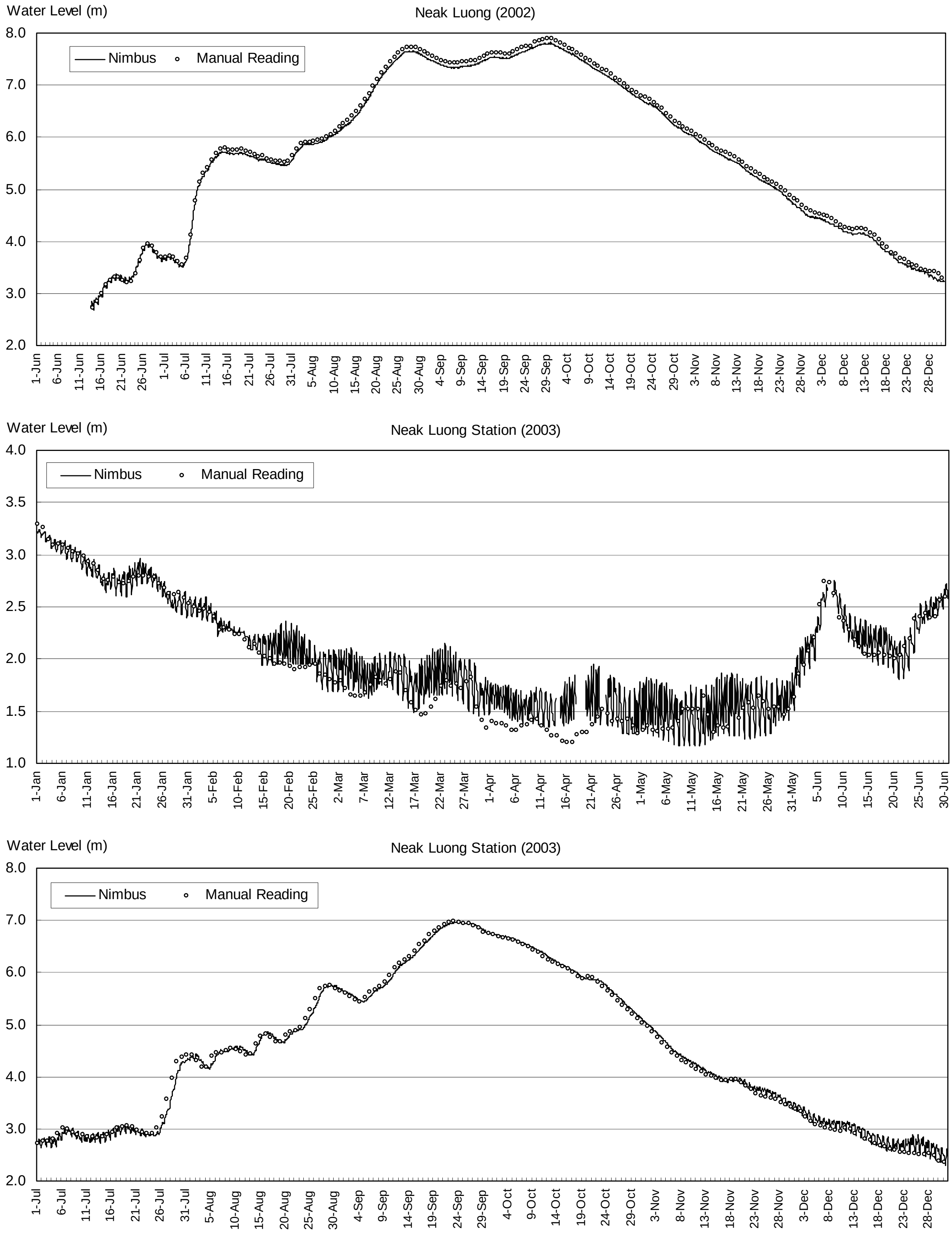



**Fig. 2.9 Measured Data of Neak Luong Station**

This station is stilling well type. This type allows sediment accumulation in the well easily as aforesaid. Therefore, maintenance is very important such as removing sediment at least once a year. Actually, the sediments were removed in the main well, pilot well and connection pipes by DHRW in the 2003 low flow season. Thereafter, the accuracy of measurement has increased. It is important to continue the maintenance regularly in future.

Taking the improved stations as a whole, they have major problems in common as follows:

- Gap in connection with passage of time
- Sediment problem

The solution for the former is periodical maintenance. At the time of data collection, the gap between Nimbus data and manual reading value should be checked, and the value in Nimbus should be readjusted if necessary. This maintenance should be conducted at least once every three months, but it depends on the condition.

Regarding the sediment problem also, it is important to maintain the station periodically. Sediment around the outlet of measuring tube should be removed, or from the stilling well extensively at least once a year. Daily maintenance such as cleaning around the station and the removal of garbage, plastic bags and so on caught on the measuring pipe is also very important.

Both problems could be solved by periodical maintenance. Therefore, it is important to provide maintenance to every station regularly for keeping the accuracy of data and avoid the occurrence of missing data.

**Table 2.2 Operating Conditions of Hydrological Stations and Planned Improvement Works**

| Network Classification | Station | River | Country | Type of Gauge and Recorder | Condition of Equipment and Facilities | Improvement Works (Construction / Installation) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope Gauge | Stairway | Rebuilding of Well Type Station | Gas-purged Sensor and Data Logger |
| Key | Ubon | Nam Mun | Thailand | Manual (Vertical Staff Gauge) | Good | | | | ○ |
| Key | Pak Kagnung | Nam Ngum | Lao PDR | Manual (Vertical Staff Gauge) | No stairway | ○ | ○ | | ○ |
| Key | Ban Phonesy | Nam Cading | Lao PDR | Manual (Slope Gauge) | Good | | | | ○ |
| Key | Ban Keng Done | Se Bang Hiang | Lao PDR | Manual (Slope Gage), Automatic (Gas purge sensor, logger) | No stairway, Deterioration of slope gauge | ○ (Repainting only) | ○ | | |
| Key | Ban Komphoun | Se San | Cambodia | Manual (Vertical Staff Gauge) | No stairway | ○ | ○ | | ○ |
| Primary | Cham Tangoy | Se kong | Cambodia | Manual (Vertical Staff Gauge) | No stairway | ○ | ○ | | ○ |
| Key | Chak Tomuk | Bassac | Cambodia | Manual (Slope Gauge) | Good | | | | ○ |
| Key | Neak Luong | Mekong | Cambodia | Manual (Vertical Staff Gage), Automatic (Float type recorder) | Deterioration of facility and recorder | | | ○ | ○ |
| Key | My Thuan | Mekong | Vietnam | Manual (Vertical Staff Gauge) | To be relocated | | | | (○) |

**Note:** SRHMC planned to relocate and reconstruct the My Thuan Station in 2002 so that gas purged sensor and data logger could be installed.

# Fig. 1.1 SCHEMATIC DIAGRAM OF MAJOR HYDROLOGICAL NETWORK IN LOWER MEKONG BASIN

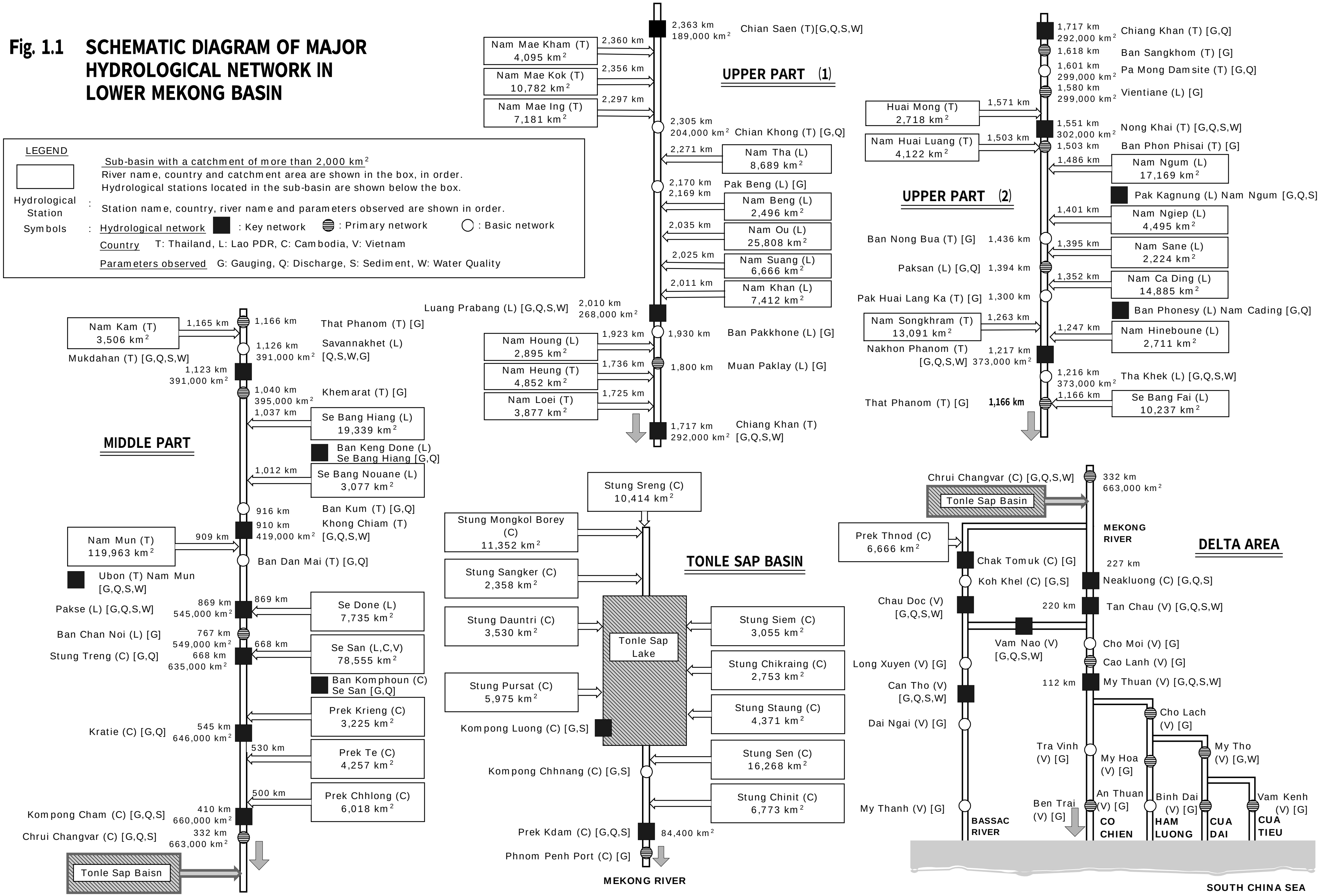



**Fig. 2.1 (1) Location Map of Ubon Station in Thailand**


**Fig. 2.1 (2)** **Location Map of Improved Stations in Lao PDR**


**Fig. 2.1 (3) Location Map of Improved Stations in Cambodia**


**Fig. 2.1 (4) Location Map of My Thuan Station in Vietnam**

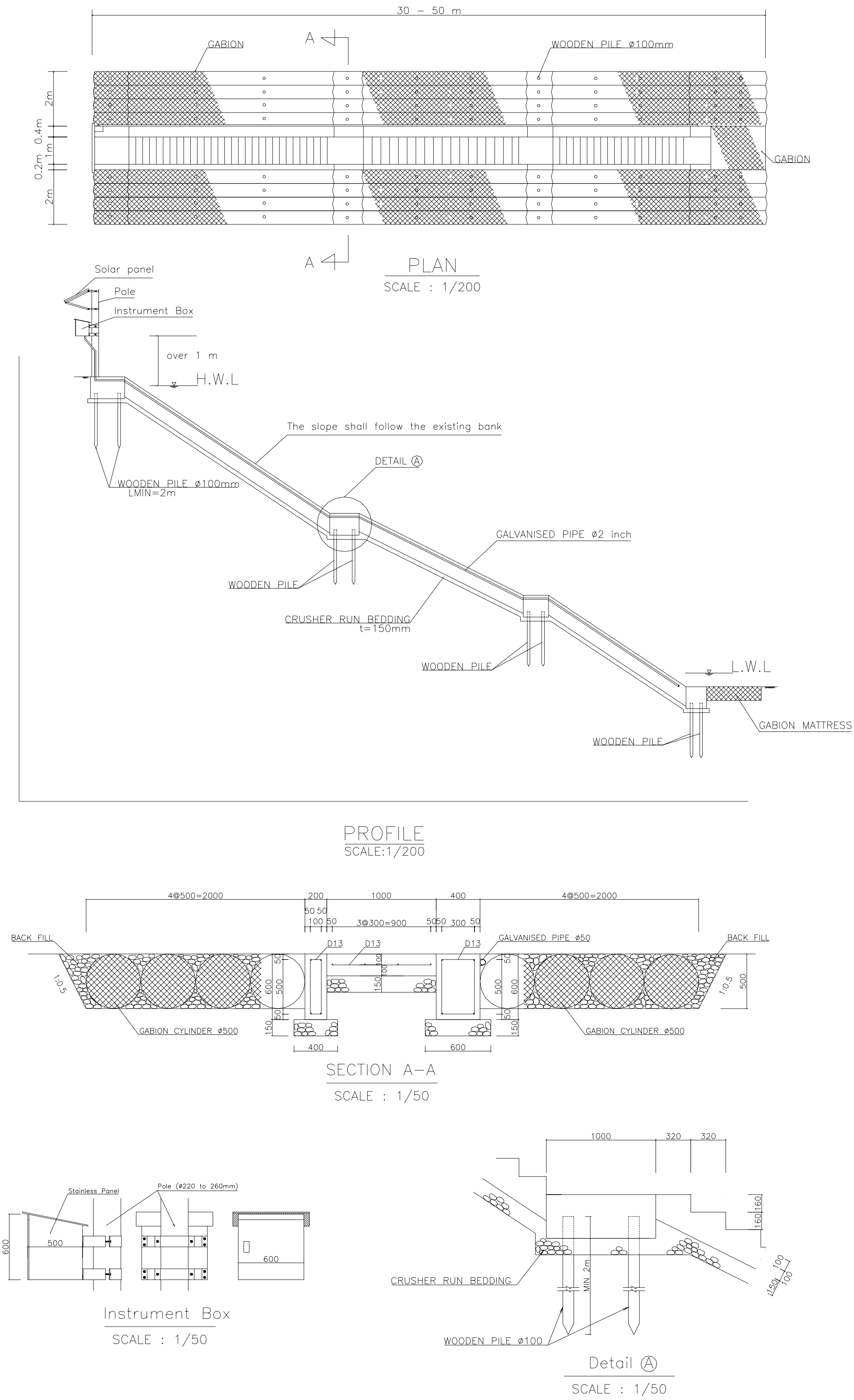



**Fig. 2.2(1) General Design (Slope Gauge)**

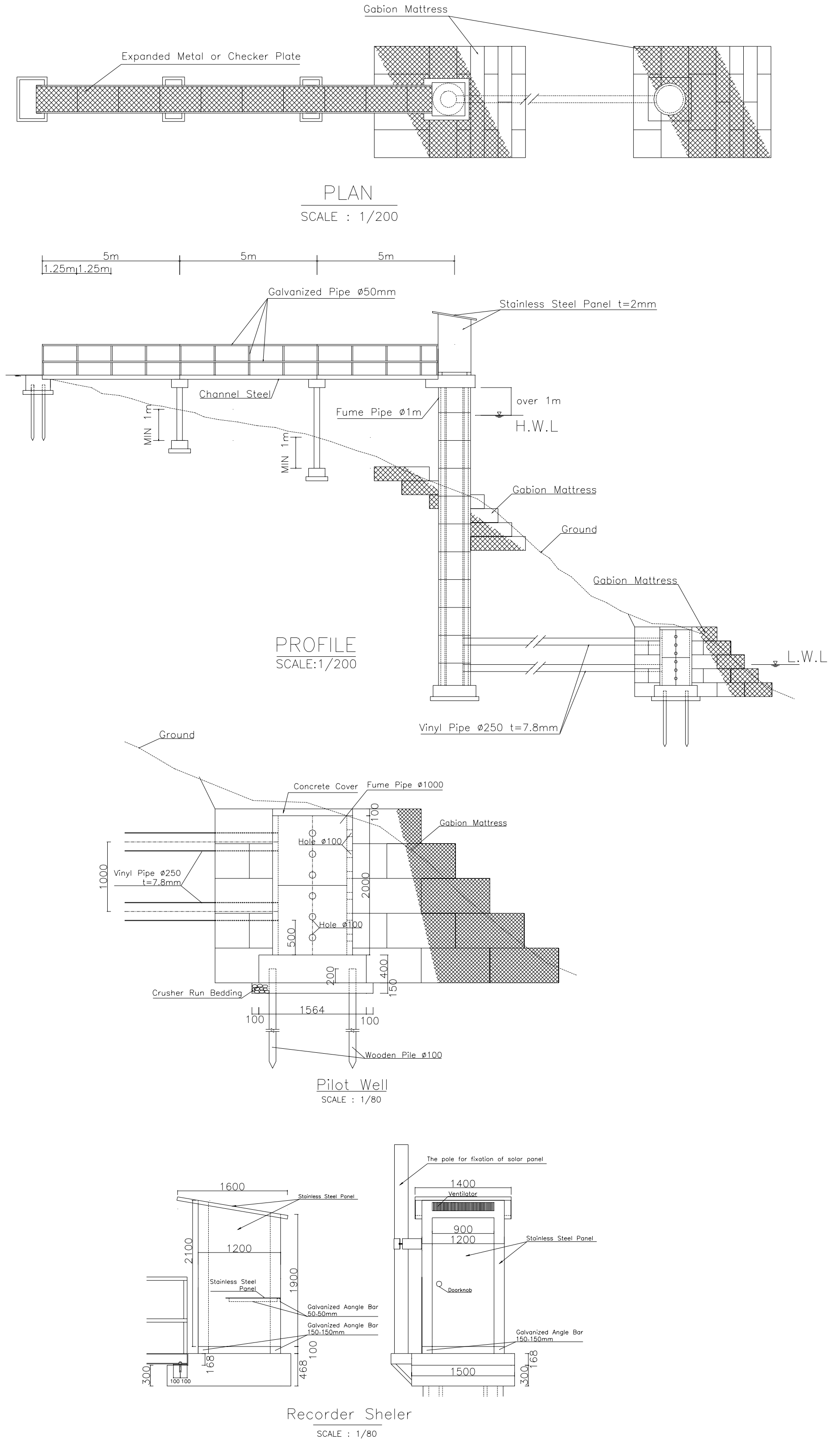



**Fig. 2.2(2) General Design (Float Type)**

# *ANNEX I*

## *PHOTOS OF IMPROVED HYDROLOGICAL STATIONS*

## Photos of Improved Ubon Station (Nam Mun) in Thailand

# Photos of Improved Stations in Lao PDR

## Pak Kagnung Station (Nam Ngum)

**Ban Phonesy Station (Nam Cading)**

**Ban Keng Done station (Se Bang Hieng)**

# Photos of Improved Stations in Cambodia

## Ban Komphoun Station (Se San)

## Cham Tangoy Station (Se Kong)

## Chak Tomuk Station (Mekong/Tonle Sap)

## Neak Luong Station (Mekong)

# *ANNEX II*

# *TRAINING IN THAILAND AND LAO PDR*

**Installation of Measuring Equipment and Training in Lao PDR**

Date: 28 to 30 October 2002

Attendance List

| Name | Organization | Position |
|---|---|---|
| Khanmany Khounphonh | Department of Meteorology and Hydrology | Chief of Technical Division |
| Nikhom Keosavang | ditto | Deputy Chief of Hydro-Meteo Data Collection Centre |
| Yuichiro Hamada | WUP-JICA | Hydrological Monitoring |

Schedule:

1st Day: 28 October

Installation of Measuring Equipment for Pak Kagnung Station

2nd Day: 29 October

Installation of Measuring Equipment for Ban Phonesy Station

3rd Day: 30 October

Indoor Training for Handling Nimbus and HYDRAS 3 Software

## OJT at the Ban Phonesy Staion

## Indoor Training at DMH Office in Lao PDR on 30 October 2003

## Training for Nimbus Operation in Thailand

Date: 16 January 2003

Attendance List:

| Name | Organization | Position |
|---|---|---|
| Kornika Taweesup | Department of Water Resources | Director of Research and Development Hydrology |
| Wandee Pattanasatianpong | ditto | Chief of Hydrological Equipment Standard Section |
| Wachira Somkhane | ditto | Chief of Ubon Ratchathani Hydrological Centre |
| Jirapay Thongklee | ditto | Field Hydrologist |
| Wirith Intharacharoen | ditto | Field Observer |
| Tongchai Phawaputanon | ditto | Field Observer |
| MORISHITA Kanehiro | WUP-JICA | Team Leader |
| HAMADA Yuichiro | ditto | Hydrological Monitoring |

Schedule:

16 January AM: Indoor Training on the operation of HYDRAS 3 software

PM: On-the-Job Training at Ubon Station

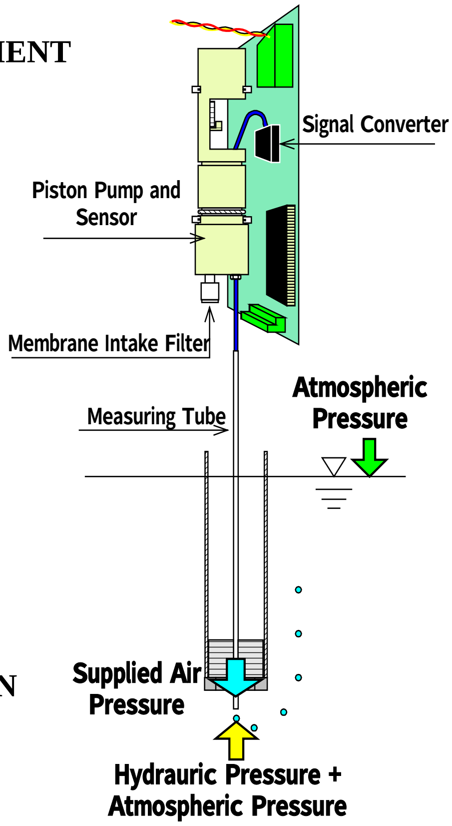
### OJT at Ubon Station

## Indoor Training at Hydrological Centre in Ubon on 16 January 2003

# *TRAINING MATERIALS*

## *(TRAINING ON NIMBUS OPERATION)*

## 1. PRINCIPLE (PROCEDURE) OF MEASUREMENT




A) Compressed air generated by the piston pump flows through the measuring tube and the bubble chamber into the water to be measured.

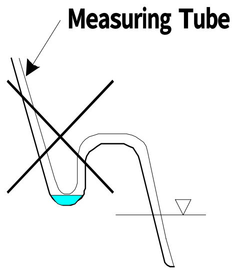
B) The excess pressure formed in the measuring tube is directly proportional to the water column above the bubble chamber.

C) The Nimbus sensor calculates first the Atmospheric Pressure and then the Bubble in Pressure.

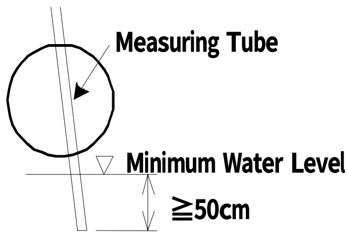
D) By examining the difference between the two signals (Atmospheric pressure and bubble in pressure), the Nimbus sensor calculates the height of the water level above the bubble chamber.

## 2. POINTS OF CONCERN FOR INSTALLATION OF MEASURING TUBE

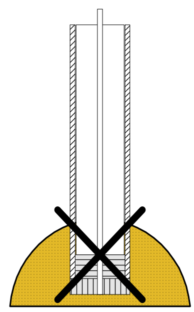
A) The length of measuring tube should be less than 100 m.
The measuring tube might as well be shorter. If the tube length goes beyond 100 m, the external influence to the tube will be extensive and the sensibility will be worse. It might be the cause of missing data.




B) The pipe arrangement should be straight to avoid bending U-shaped.
If the tube were installed with bending U-shaped, water will be pooled in the bottom of the U-shaped tube and this will interrupt air supply. Thus the tube should be installed into the water at a straight and steep angle.
The bottom end of the tube should be installed 50 cm lower than minimum water level.




C) The bottom end of the tube should be installed perpendicular to the flow direction or tilting slightly towards upstream (The outlet should face slightly towards downstream).
If the bottom end of the tube were installed facing the flow direction, it will be influenced by hydrodynamic pressure and this will be a cause of accidental error.



D) The bottom end of the tube should not be buried in sediment.
If the bottom end of tube were buried in sediment, the bubble cannot run out and this might be a cause

of error. It is important to clean the space around the bottom end of the tube during maintenance.

## 3. NIMBUS AND HYDRAS 3 APPLICATION SOFTWARE

Nimbus, which operates on the bubble-in principle, has several versions to suit various measuring stations. The Nimbus provided for this project is "Sensor card with integrated data logger as stand-alone version in the HYDROSENS-MIDI housing".

Nimbus does not require any particular maintenance if the sample interval is more than 5 minutes.

A PC with serial interface and the HYDRAS 3 software are indispensable for setting the operating parameters for the stand-alone version.

The HYDRAS 3 software is based on a high-performance database application, which comes with a variety of functions as below. Among the main applications of HYDRAS 3 is OTT devices communication and operation (configuration).

- Communication with OTT devices (downloading data)
- Operating OTT devices (configuration)
- Station management (management of master data)
- Time sequence management
- Incorporating map or graphic material
- Graphical evaluation
- Multiple graphics
- Graphical editor
- Numerical display of measured data
- Virtual sensor
- Correlation analysis
- Importing Exporting measurement data, and so on

The WUP-JICA Team intends to explain the most important functions such as downloading data and configuration of Nimbus in this training.

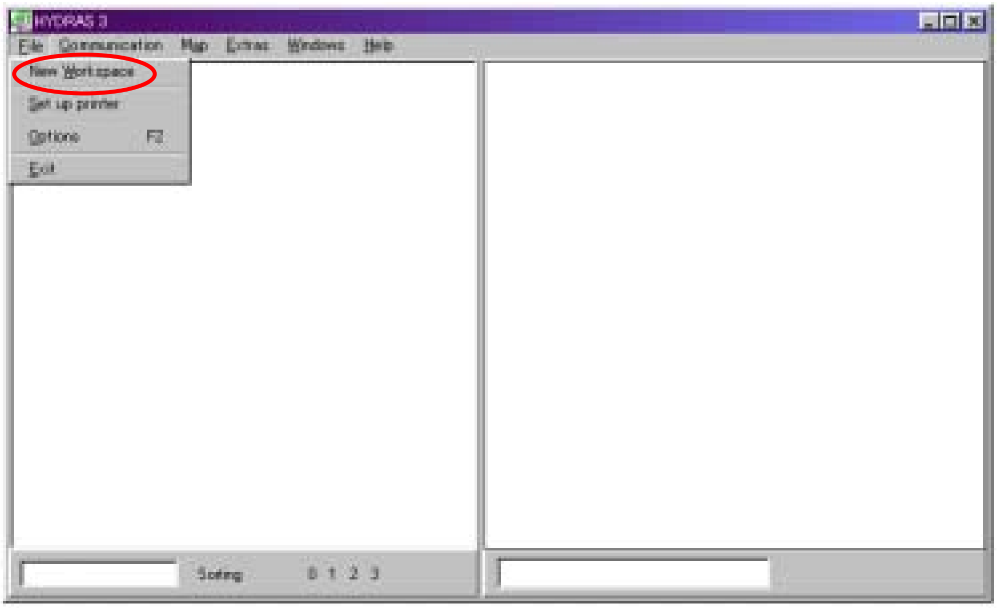
HYDRAS 3 updates can be downloaded free of charge from the Internet Homepage below:

http://www.ott-hydrometry.de/english/cmcshome.htm

## 4. STARTING HYDRAS 3 FOR THE FIRST TIME

There are no entries in the HYDRAS 3 main window when the software is started for the first time. You must therefore first create a "workspace" in which the individual stations and sensors can be grouped at a later stage.

To create a new workspace, select the "File | New workspace" menu item in the main window. Alternatively, you can click an empty range in the tree display with the right mouse button and select "New workspace" in the pop-up menu displayed. You now need to specify a name and number for the workspace. Finally, you must specify a path for the workspace. All configuration data for this workspace (including measuring stations and sensors) are saved in this path.



**Creating a Workspace**

## 5. THE HYDRAS 3 MAIN WINDOW

The starting point for operating HYDRAS 3 is the main window, which is divided into two sections:

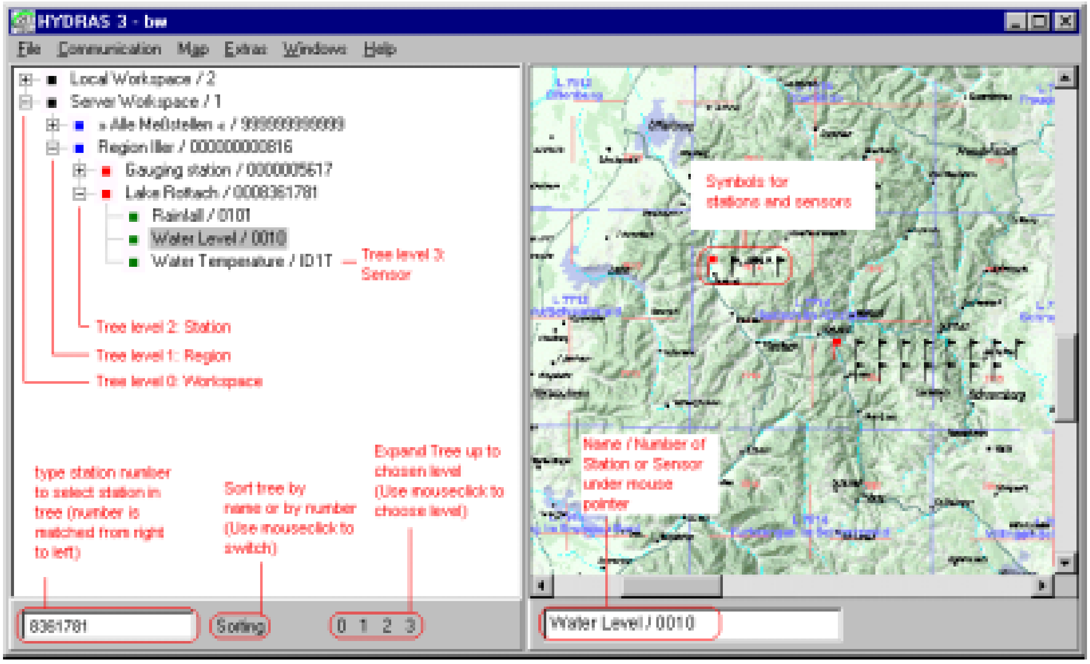
- Tree display
- Map

The tree display represents the logical management structure under Workspaces, Regions, Stations and Sensors. The map displays the object selected in the tree display. Now we do not have map data. However, HYDRAS 3 will function well without map data.

HYDRAS 3 is mainly operated using context menus (pop-up menus). To perform an operation on an object, you have to position the mouse on it and click the right mouse button. A menu is then displayed which contains all of the operations available for that object.

All of important information for the regions, stations and sensors are saved in the property windows of HYDRAS 3 (master data).
Use the right-hand mouse button to click on a region, station or sensor in tree display and

select "Properties" in the context menu. If the desired region (or station, sensor) has not been created, click with the right-hand mouse in the tree display on the workspace (or region, station) and select the context menu "New region (or station, sensor)".




**The HYDRAS 3 Main Window**

## 6. COMMUNICATION WITH NIMBUS

The core of HYDRAS 3 is its communication function. With the HYDRAS 3, you can operate Nimbus (configuration), and download measured data from Nimbus.

### 6.1 Configuring Devices

To configure Nimbus, call up the "Communication | Read/Operate" menu item in the HYDRAS 3 main window.

This menu item can also be called up directly from the pop-up menu on the objective station. The following dialog box then appears.

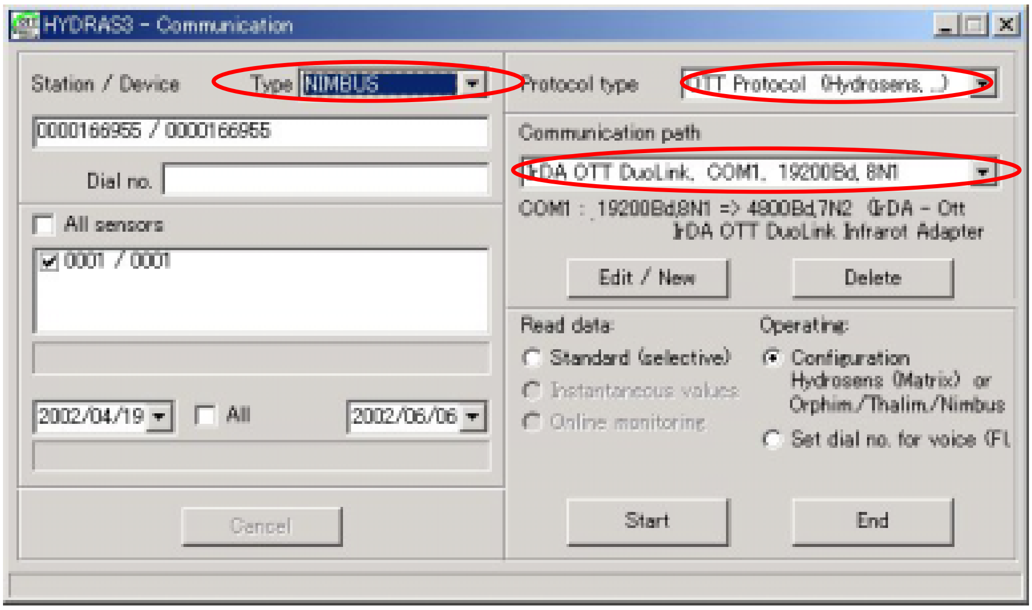
You should select an appropriate means of communication. In the column of Type, you should choose "Nimbus" of course. And HYDRAS 3 sets up automatically the protocol type for data transfer. At first "OTT protocol 2 (selective)" is selected automatically. If this setting cannot be communicated with Nimbus, "OTT protocol 2 (total)" should be tried.

Under "Communication path" select which interface and devices to use for configuration. A number of standard settings are available. These can be individually customised to suit your PC configuration and saved.

"Communication path" is "IrDA OTT DuoLink, COM X, 19200Bd, 8N1".

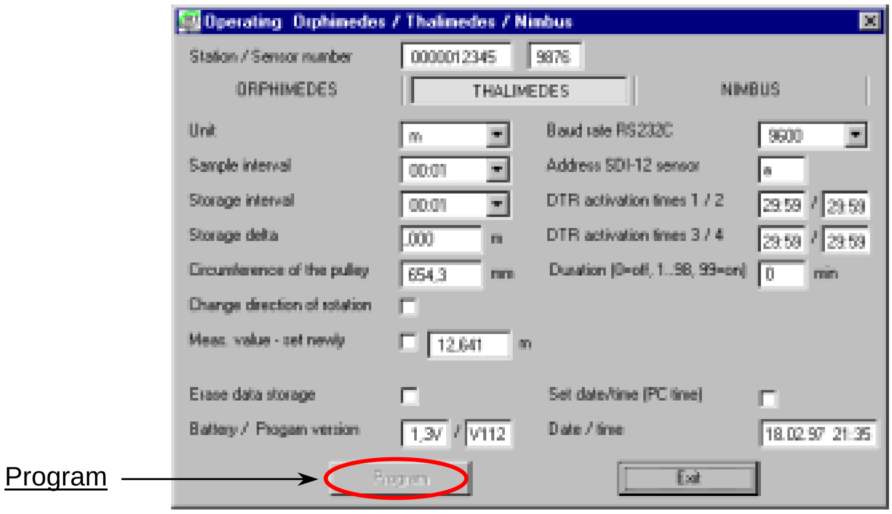
You should set as above usually and choose the appropriate communication port.

Click the "Start" button to start configuring the device selected under Station/Device.




**Context Menu of Communication**

The set of parameters is immediately input and displayed in the following dialog box (the example illustrates Thalimedes, one of the OTT devices, and it is a close resemblance to Nimbus).




**Example of Configuring OTT Device**

You can now adjust the individual parameters and transfer them to Nimbus by clicking the "Program" button. Load and display the parameter set immediately afterwards to check the data.

The principle parameters are set generally as follows:

| | |
|---|---|
| Sample interval: | 0.25 - 1.0 (hour) |
| Storage interval: | 1.0 (hour) |
| Storage delta*: | 0.0 (m) |
| Meas. tube length: | Enter the length of the measuring tube when first set up |

Meas. value/set newly: Enter the water level reading manual gauge when first set up and the gap between the automatic and manual would be happened.

** If the difference between the previously stored data and the current measured value is less than the value of storage delta, the measured data is not stored. If 0 (zero) is entered, Nimbus saves all measured values regardless of size.*

It is not necessary to change the other parameters. They should be kept at their default value.

## 6.2 Downloading Data

To download data from Nimbus, call up "Communication | Read/Operate" from the menu in the HYDRAS 3 main window. You should select an appropriate means of communication in the same way as configuring the Nimbus.

If you wish to download data from individual sensors, check them in the sensor list box.

Set the downloading period using the appropriate date boxes or select "All" to download all data.

Communication is activated when you click the "Start" button.

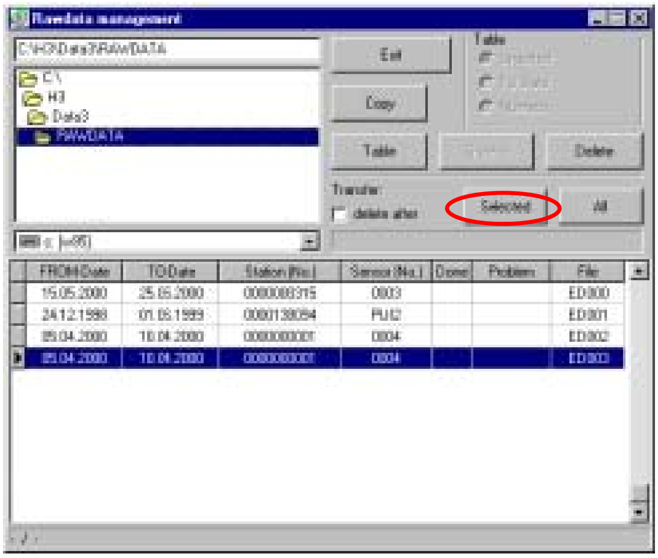
Please note that all measurement data are in raw data format right after the data has downloaded. Therefore, they must be converted into the database format using "Raw data transfer" function.

# 7. RAW DATA MANAGEMENT

All measured data to be transferred from Nimbus to the HYDRAS 3 application software are initially in raw data format.

The function "Raw data transfer" in the communication menu converts these raw data into the specific HYDRAS 3 data format.

To transfer raw data, select the "Raw data management" menu item under the "Communication" menu in the HYDRAS 3 main window. This opens the dialog box illustrated below, where you can select the source directory for the raw data. As soon as you have selected a source directory, a list of available raw data files is displayed in the table. Double-click on the relevant line or click the "Selected" button to transfer the raw data file to the HYDRAS 3 measured value database. If you click the "All" button, all raw data displayed is transferred to the database.



**Raw Data Transfer**

If raw data are downloaded from a sensor that has not yet been set up in the system, HYDRAS 3 asks you if you want to automatically create a configuration for this sensor.

Clicking the “Delete” button results in the selected raw data file being deleted.

By clicking the “Table” button you can view the contents of the selected raw data file in tabular view in a separate window. The displayed content can be printed from this window.

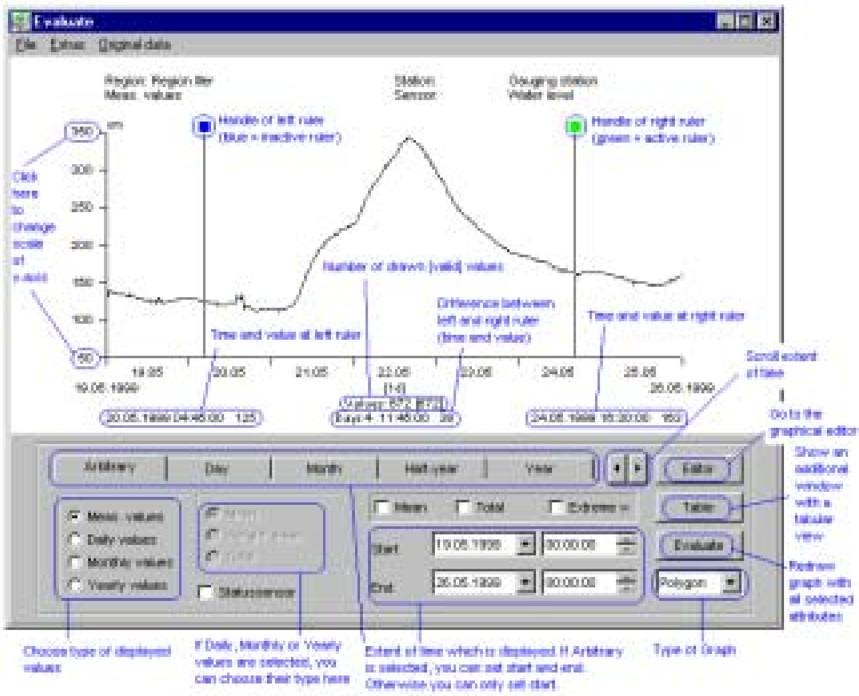
Instead of selecting only one raw data file for the different functions, you can also select multiple raw data files from the list by clicking the mouse button while keeping the “Ctrl” key pressed.

By clicking the “Exit” button you can close the raw data management window.

## 8. EXPORTING MEASURED VALUES

To enable you to use data from HYDRAS 3 in other programs, HYDRAS 3 offers you the option of exporting measured value sequences in text file format. The format of this export file can be more or less freely selected in the Export dialog box.

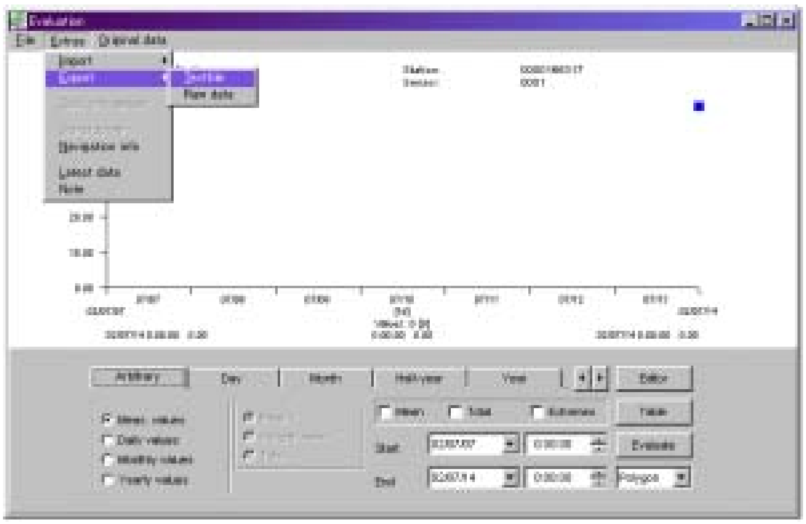
To export data from a sensor, first open an evaluate window for the sensor. The evaluate window is called up by clicking a sensor with the right mouse button in the tree display. Selecting the “Evaluate” menu item in the pop-up menu is displayed as a result.




**Example of Evaluate Window**

A<u>djust the period until the exact range of data that you wish to export is visible on the screen</u>. Also <u>select the type of value</u> that you wish to export here (Measured Values, Daily Means, Daily Totals, Monthly Means, etc.).

Once you have made these settings, <u>select the "Extras | Export | Text file"</u> menu time in the evaluate window. A file dialog box appears; enter the name and path of the export file here. Click "Save" and the export file will be created.




**Exporting Data**

## 9. MAINTENANCE

As mentioned above, Nimbus is maintenance-free. However, in order to ensure smooth and problem-free data acquisition, it is recommended that the entire electrical system should be checked at regular intervals (at least once a year).

**Checking the Solar Panel**

- Check the solar panel for mechanical damage.
- Check the azimuthal and angles of panel.
- Check whether all screws are securely tightened and the module is securely anchored.
- Check all connection leads for corrosion or loosening.

**Checking the Battery**

- Check the terminals for corrosion and loose cable connections
- Replace batteries ideally after 5 years. This is particularly important for systems with very important measurement values.

## REFERENCES:

(1) OTT HYDROMETRIE: Operating Instructions on the Intelligent Sensor Card Using the Bubble-In Principle Nimbus

(2) OTT HYDROMETRIE: Getting Started with HYDRAS 3