摘　要

一、 計畫內容

本計畫經蒐集阿公店水庫與阿公店溪基本資料及現地勘查、斷面樁補設、控制點及斷面樁之平面與高程控制測量後，再於阿公店水庫空庫防淤操作(6/1~9/10)前、後各進行一次水庫地形測量，並於空庫防淤操作後進行阿公店溪河道斷面測量，以建立本(111)年度空庫防淤操作前、後水庫庫區地形暨下游阿公店溪的河道斷面資料，瞭解現有水庫蓄水容量及地貌變化情形，相關資料亦可回饋未來運轉操作檢討之參考。主要內容包含：

1、 阿公店水庫斷面樁坐標及高程測量。
2、 阿公店水庫庫區及上游河道斷　面及地形測量，分別於水庫空庫防淤期（6/1~9/10）前、後各 1 次。
3、 阿公店溪河道斷面測量，阿公店溪自水庫溢洪管出口至出海口，全長約 17.9 公里，共 59 處河道橫斷面測量總計施測 1 次，本項測量工作於阿公店水庫空庫防淤操作期後(9/10 後)執行。

本計畫測量成果因包含阿公店水庫及阿公店溪二部份，而二者採用不同的高程系統，故在此說明其所用系統及二系統間之關係：

阿公店溪斷面高程採用內政部公告之 TWVD2001 一等水準高程系統，在阿公店水庫部份則採用阿公店水庫高程系統，而內政部一等水準系統與阿公店水庫高程系統二者高程差異為 0.413m，其關係為「阿公店水庫高程=TWVD2001 一等水準高程-0.413m」。

二、 阿公店水庫地形測量成果

鑒於 94 年 8 月阿公店水庫更新改善工程完工後，於汛期將採行空庫防淤操作，為了解其空庫防淤操作之成效，需進行水庫庫區地形測量工作，計算水庫現有容量、地貌變化情形。依此目的，本項工作於空庫防淤操作 6/1~9/10 前、後(即 5 月底前與 9 月 10 日後)各進行一次地形測量工作。

測量範圍為阿公店水庫庫底施測至最高洪水位標高 40 公尺處，採 1/2,000 比例尺測繪，施測面積約 365 公頃。本計畫二次地形測量成果，在最大蓄水高程標高 37m 的蓄水容量比較結果說明如下：

1、 111 年 5 月，蓄水容量為 1,523.251 萬立方公尺，蓄水面積為 295.545 公頃，在歷經約 16.76 年期間後(94 年 8 月至 111 年 5 月)，水庫在滿水位標高 37 公尺之累計淤積量達 313.828 萬立方公尺(因淤積大於沖刷，故僅標示累計淤積量)，淤積率為 17.09%，年平均淤積量為 18.725 萬立方公尺/年。

2、 111 年 9 月，蓄水容量為 1,519.808 萬立方公尺，蓄水面積為 296.375 公頃，在歷經約 17.09 年期間後(94 年 8 月至 111 年 9 月)，水庫在滿水位標高 37 公尺之累計淤積量達 317.270 萬立方公尺，淤積率為 17.27%，年平均淤積量為 18.565 萬立方公尺/年。

3、 自 111 年 5 月至 111 年 9 月止，蓄水容量由 1,523.251 萬立方公尺，減少為 1,519.809 萬立方公尺，水庫容量減少 3.443 萬立方公尺，容量減少比率為 0.18%。

4、 自 110 年 9 月至 111 年 9 月止，蓄水容量由 1,527.596 萬立方公尺，減少為 1,519.809 萬立方公尺，水庫容量減少 7.788 萬立方公尺，容量減少比率為 0.42%。

三、 太陽能光電區地貌變化

1、 110 年 9 月至 111 年 9 月間，地形高程呈現增高與降低互現之情形，量級約在 ±0.2m 間。

2、 111 年 5 月至 111 年 9 月，地形高程呈現增高與降低互現之情形，量級約在± 0.1m 間。

3、 太陽能板專區高程約在 EL30~31m 左右，空庫防淤操作時，藉由庫區深槽溝(EL28~29m)進行水力排砂至溢洪管，水庫蓄水高度未達太陽能板專區之高度，不會有泥砂落淤於此區，故沒有明顯的侵淤變化情形。

四、 水庫縱斷面變化

1、旺萊溪縱斷面之歷年變化，約在橫斷面 S14-1(里程約 1K+500m)有一明顯區分，在橫斷面 S14-1 至溢洪管口區間，由 94 年起水庫底床高程逐年增加，且庫底高程由 94 年之 EL.27.0m 左右增加至 104 年之 EL.28.3m 左右，104 年至 111 年間則由 EL.28.3m 左右增加至 EL.29.5m 左右。而在橫斷面 S13 至 S15 處呈現高程較為 110 年增加之情形。橫斷面 S15-1 至 S17 區間則變換情形較不明顯; 橫斷面 S17-1 往上游則是呈現增高的趨勢。

2、濁水溪縱斷面之歷年變化，約在橫斷面 S02(里程約 1K+900m)入庫處可作一區分，在橫斷面 S02 至溢洪管口區間，由 94 年起水庫底床高程逐年增加。橫斷面 S06-1 至 S03-1 區間有較為 110 年 9 月高程增加的趨勢；橫斷面 S03 至 S02-1 區間因辦理抽泥作業故高程降低；橫斷面 S02 往上游則呈現略為增高的趨勢。

五、 阿公店溪河道斷面測量成果

1、本年度斷面資料計算平均河床高與 110 年平均河床高比較(正值代表淤積，負值代表沖刷)，概述如下：

- 河口至維仁橋以沖刷為主，沖淤深度介於-0.07~+0.08m。
- 維仁橋至土庫排水以淤積為主，沖淤深度介於-0.04~+0.11m。
- 土庫排水至鐵路橋以沖刷為主，為本次斷面測量沖刷量最大河段(-0.33~-0.17m)，河段沖刷量約為-29,796m^3，約占全河段沖淤總量-57,355m^{3}之 51.95%。
- 鐵路橋至過溪橋以沖刷為主，沖淤深度介於-0.23~+0.12m。
- 過溪橋至高鐵橋以沖刷為主，沖淤深度介於-0.53~+0.05m。
- 高鐵橋至水庫輸洪管出口，以淤積為主，沖淤深度介於-0.11~+0.13m。

2、由本年度與 110 年的沖淤量成果比較，各段平均沖淤高度(正值代表淤積，負值代表沖刷)為：河口至維仁橋為-0.05m、維仁橋至土庫排水為+0.01m、土庫排水至鐵路橋為-0.19m、鐵路橋至過溪橋為-0.01m、過溪橋至高鐵橋為-0.12m、高鐵橋至水庫輸洪管出口為+0.01m；而全河段則呈現-0.05m 之沖刷狀態。

Abstract

This program contains varies data collected from Agongdian Reservoir and Agongdian Rivers which include: basic information, land survey investigation, setting of concrete survey marker, and the altitude and horizontal measurements of control point and survey marker. Topographic surveys of the reservoir were carried out before and after the “Empty Storage Operation for Sediment Prevention Program” (ESOSPP) (June 1 to September 10). A river cross-section profile survey was carried out after the ESOSPP to establish the data for Pre-post Emptying Storage Sediment Prevention Topography report and the downstream river cross-section of 2022. All the data allow a better understanding of the current water storage capacity and topographical changes circumstances. The related data can also be used as a reference for future ESOSPP.

I. Scope of Work and Content

This program includes:

1. Coordinate and elevation measurements of the new concrete survey markers located around the Agongdian Reservoir area and the upstream river section.
2. Topographic survey and river cross-section profile survey of the Agongdian Reservoir area and the upstream river channel, respectively before and after the ESOSPP (June 1 to September 10).
3. Cross-section profile survey of the reservoir water outlet and estuary (17.9km distance in total and 59 river cross-section surveys). This survey was executed after the ESOSPP (September 10).

Since this survey includes the Agongdian Reservoir and the Agongdian River, both adopt different elevation systems. The relationship between two systems are therefore explained as below:

The Agongdian River survey uses the Ministry of Interior TWVD2001 level elevation system. On the other hand, the Agongdian Reservoir survey uses its own elevation system so called “The Agongdian Reservoir Elevation System”. Thus, the altitude differences between both systems has been determined to 0.413m. It converts into the following formula: **“Agongdian Reservoir Elevation System = TWVD2001 Elevation System – 0.413m”**

II. Agongdian Reservoir Topographic Survey Results

Since the Agongdian Reservoir Improvement Project was completed, the ESOSPP has been carried out during the flooding period. In order to understand the effectiveness of the ESOSPP, a topographic survey of the reservoir must be achieved to evaluate the existing volume, the erosion and the deposit variation. Thus, the topographic survey was achieved respectively before and after the ESOSPP (one was before the end of May and the other one was after September 10th).

The Agongdian survey ranges from the bottom of the reservoir to the 40m height marker (highest flood level) at a 1/2000 survey mapping scale for a total area of 365 hectares. The comparison between before and after the ESOSPP with maximum water storage height at the 37m marker are as follows:

1. 2022 May survey result:

- Water storage capacity = 1,523.251 × $10^4 m^3$
- Water storage area = 295.545 × $10^4 m^2$
- After a period of more than 16.76 years (from 2005 August to 2022 April), the accumulated sediment volume of the reservoir at 37m marker water level was 313.828 × $10^4 m^3$. Deposit rate at 17.09% and the annual average sedimentation is 18.725 × $10^4 m^3$/year.

2. 2022 September survey result:

- Water storage capacity = 1,519.809 × $10^4 m^3$
- Water storage area = 295.545 × $10^4 m^2$
- After a period of 17.09 years (from 2005 August to 2022 September), the accumulated sediment volume of the reservoir at 37m marker water level was

$317.270 \times 10^4 m^3$. Deposit rate at 17.27% and the annual average sedimentation is $18.565 \times 10^4 m^3$/year.

3.From 2022 May and 2022 September surveys comparison:

- The water storage volume has decreased by $3.443 \times 10^4 m^3$, which represents a 0.18% decrement ratio.

4.From 2021 September and 2022 September surveys comparison:

- The water storage volume has decreased by $7.788 \times 10^4 m^3$, which represents a 0.42% decrement ratio.

III. Landform Changes in Solar Panels Area

- From 2021September to 2022 September, the terrain elevation showed a situation of mutual increase and decrease, and the magnitude was about ± 0.2m.
- From 2022 May to 2022 September, the terrain elevation showed a situation of mutual increase and decrease, and the magnitude was about ± 0.1m.
- The landform changes of the solar panel area is consistent with the trend of the surrounding area.
- The elevation of the solar panel area is about EL. 30m to EL. 31m. When the ESOSPP performed, the hydraulic sand discharge from the deep trench to the overflow pipe is located at EL. 28m to EL. 29m. The water storage height of the reservoir does not reach the height of the solar panel area. Therefore, no sand falling and silting in this area and no distinct changes in invasion and silting.

IV. Changes in the Cross-Section of the Reservoir

- The changes in the Wanglai River profile over the years has a clear distinction at cross-section S14-1 (mileage at about 1K + 500m). From the cross-section S14-1 to the overflow pipe opening, the reservoir bottom bed has been increasing since 2005 to 2015. The elevation of the bottom of the reservoir has increased form EL. 27m to EL. 28.3m. From 2015 to 2022, the elevation of the bottom of the reservoir has increased form EL. 28.3m to EL. 29m. Between cross-sections S13 to S15, there was a increasing trend comparing to September 2021. The elevation changes between cross-sections S15-1 to S17 are not obvious. The upstream of the cross section S17-1 shows an increasing trend.

- The changes in the Zhuoshui River profile section over the years can be distinguished at the entry point of the cross-section S02 (mileage approximately at 1K + 900m). From the cross-section S02 to the overflow nozzle, the elevation of the reservoir bottom bed has been increased since 2005. The elevation was a increased trending between cross-section S06-1 to S03-1 that compared with September 2021. The elevation between cross-sections S03 to S02-1 had decreased because of the dredging engineering. The upstream of the cross section S02 shows an increasing trend.

V. Agongdian River Cross-Section Survey Result

1. Comprising between this year and last year riverbed elevation changes (Positive means siltation, negative means erosion) base on the cross-section and is as follow:

- Agondian river estuary - Weiren Bridge: mainly erosion. Flushing elevation at about -0.07m to +0.08m.
- Weiren Bridge - Tuku drainage: mainly siltation. Flushing elevation at about -0.04m to +0.11m.
- Tuku drainage - train railway bridge: mainly erosion. Flushing elevation at about -0.33m to -0.17m. The flushing volume is about -29,796m^3, which represents 51.95% of the whole river flushing volume, -57,355m^3.
- Train railway bridge - Guoxi Bridge: mainly erosion. Flushing elevation at about -0.23m to +0.12m.
- Guoxi Bridge - high-speed railway Bridge: mainly erosion. Flushing elevation at about -0.53m to +0.05m

- High-speed railway bridge - reservoir water outlet: mainly siltation. Flushing elevation at about -0.11m to +0.13m

2. Comprising between this year and last year deposit result, the average deposit height variation (Positive means siltation, negative means erosion) has been determined by the cross-section and is as follow :

- Agondian river estuary - Weiren Bridge: -0.05m
- Weiren Bridge - Tuku drainage: +0.001m
- Tuku drainage - train railway bridge: -0.19m
- Train railway bridge - Guoxi Bridge: -0.01m
- Guoxi Bridge - high-speed railway bridge: -0.12m
- High-speed railway bridge - reservoir water outlet: +0.01m
- The whole river section variation: -0.05m

結 論 與 建 議

一、結論

一、　本年度 111 年 9 月空庫防淤操作後測量成果與去年度 110 年 9 月空庫防淤操作後測量成果比較，在最大蓄水高度標高 37m 之總蓄水容量分別為 1,519.808 萬立方公尺及 1,527.596 萬立方公尺，水庫總蓄水容量減少 7.788 萬立方公尺，減少比率為 0.42%。庫區地形高程呈現增加及降低互現之情形。

二、　本年度 111 年 9 月空庫防淤操作後測量成果與 111 年 5 月空庫防淤操作前測量成果比較，在最大蓄水高度標高 37m 之總蓄水容量分別為 1,519.808 萬立方公尺及 1,523.251 萬立方公尺，水庫總蓄水容量減少 3.443 萬立方公尺，減少比率為 0.18%。庫區地形高程呈現增加及降低互見之情形。

三、　自 94 年 8 月水庫更新改善工程完工後，至本次 111 年 9 月空庫防淤操作後測量成果顯示，最大蓄水高度標高 37m 之總蓄水容量由 1,837.078 萬立方公尺減少至 1,519.809 萬立方公尺，在歷經 17.09 年期間，水庫在滿水位標高 37 公尺之累計淤積量達 317.270 萬立方公尺，淤積率為 17.27%，年平均淤積量為 18.565 萬立方公尺/年。

四、　旺萊溪縱斷面之歷年變化，約在橫斷面 S14-1(里程約 1K+500m)有一明顯區分，在橫斷面 S14-1 至溢洪管口區間，由 94 年起水庫底床高程逐年增加，且庫底高程由 94 年之 EL.27.0m 左右增加至 104 年之 EL.28.3m 左右，104 年至 111 年間則由 EL.28.3m 左右增加至 EL.29.5m 左右。而在橫斷面 S13 至 S15 處呈現高程較為 110 年增加之情形。橫斷面 S15-1 至 S17 區間則變換情形較不明顯; 橫斷面 S17-1 往上游則是呈現增高的趨勢。

五、　濁水溪縱斷面之歷年變化，約在橫斷面 S02(里程約 1K+900m)入庫處可作一區分，在橫斷面 S02 至溢洪管口區間，由 94 年起水庫底床高程逐年增加。橫斷面 S06-1 至 S03-1 區間有較為 110 年 9 月高程增加的趨勢；橫斷面 S03 至 S02-1 區間因辦理抽泥作業故高程降低；橫斷面 S02 往上游則呈現略為增高的趨勢。

六、　由本年度與 110 年的沖淤量成果比較，各段平均沖淤高度(正值代表淤積，負值代表沖刷)為：河口至維仁橋為-0.05m、維仁橋至土庫排水為+0.01m、土庫排水

至鐵路橋為-0.19m、鐵路橋至過溪橋為-0.01m、過溪橋至高鐵橋為-0.12m、高鐵橋至水庫輸洪管出口為+0.01m；而全河段則呈現-0.05m 之沖刷狀態。

二、 建議

一、　沖積扇前緣(EL.29m)與歷年成果相比為退縮趨勢，建議後續應再持續監測其地形變化情形做為抽泥作業之評估。

二、　本年度空庫防淤操作能量為：加強水力排砂擾動達 3.77 萬立方公尺、日昇吊橋陸挖 6.24 萬立方公尺、機械抽泥 14.06 萬立方公尺。相對於陸挖與機械抽泥之數量,水力排砂擾動量低於 110 年度(43.21 萬立方公尺),庫容亦呈現減少的趨勢；可見水力排砂擾動可顯著增加庫容。建議每年應持續進行，並配合汛期前、後淤積測量結果來檢視清淤成效。