# FLOOD AND EARTHQUAKE RISK ASSESSMENTS FOR DAMS IN MYANMAR

VICTOR NGUN KIO

PRESIDENT OF MYANMAR NATIONAL COMMITTEE ON LARGE DAMS

## Contents

# Myanmar National Committee on Large Dams (MNCOLD)

## Background

MNCOLD was established in 2013. MNCOLD became a 97th member country of International Commission on Large Dams (ICOLD) on 6 June 2014 in the 82nd General Assembly of ICOLD in Bali, Indonesia.

## The Executive Committee of MNCOLD

The Executive Committee of MNCOLD is elected biennially. The current Executive Committee of MNCOLD was elected on 5 July 2024 for the 6th term of MNCOLD for (2024 to 2026).

# Part I; General

## 1. List of Large Dams in Myanmar

ICOLD Classification of Dams

ICOLD classified dams as Large, Intermediate and Small.

The List of Large Dams in Myanmar

The list of (186) Large Dams of Myanmar was submitted to ICOLD in 2014.

The list of (55) Large Dams of Myanmar was substituted in 2023.

| | |
|---|---|
| Irrigation and Water Utilization Management Department, | (44) dams |
| Department of Hydropower Implementation, | (9) dams |
| Yangon City Development Committee, | (2) dams |

## 2. Dam Classification on Reservoir Operation System

### (1) Monthly Inflow Basis Reservoir Operation

Monthly inflows in monsoon season are sharing in dry months of the year.

### (2) Yearly Inflow Basis Reservoir Operation

Inflows of wet years are sharing in dry years.

### (3) Irrigation and Hydropower Dam

If irrigation is given first priority, power generation could only be done in irrigation season.

### (4) Pumped Storage Dam

If hydropower is dominant in generation mix, no pumped storage dams exist.

## 3. Rainfall Isohyets Map of Myanmar

Locations of dam and pumped-irrigation station are concentrated within the 60-inch isohyet line.

A yield of inflow from a catchment area for an irrigation dam is between 300 to 900 ac-ft per square-mile per year.

A yield of inflow from a catchment area for a hydropower dam is between 1200 to 2100 ac-ft per square-mile per year.

The yield of inflow from a catchment area is dependent of rainfall, catchment characteristics and water balance factors.

There are five major river basins of Mekong, Thanlwin, Sittaung, Ayeyarwady and Kaladan rivers.

## 4. Trend of Mean Yearly discharge of the Ayeyarwady River

Discharge Measurements of the Ayeyarwady have been done since the British colonial time at Seiktha.

The recorded time could be divided into three parts, the British colonial time, after Independence and after 1988.

Retention of 7.89 million acre-feet by the largest storage dams such as Thapanzeik, Yeywa, Kinda, Mone Chaung, Kyion-Kyiwa and Se Taw Gyi, etc., can affect the flow pattern of the Ayeyarwady river.

## 5. Regime Changing of the Sittaung River

About 5.32 million acre-feet of inflow is retained by Upper and Lower Paunglaung, Yenwe, Kabaung, Kun Chaung and Phyu Chaung dams.

Due to dams, the impact of floods in Pyuntaza plain was eliminated. No more disruption of rail and road transport. Elimination of sand intrusion into the paddy fields.

As sediment is trapped by dam, erosions take place just at the downstream of dam to maintain sediment concentration of flow.

The flood waters retained by dams reduce flood intensity and frequency, resulting gradual silt deposition along the Sittaung river.

# Part II; Reservoir Size Classification and Hazard Identification

## 1. Reservoir Size Classification and Hazard Potential

ICOLD Bulletin No. 82 Selection of Design Flood

Table C 1, Reservoir Size Classification

| | Reservoir Capacity ($hm^3$) | Dam Height (m) |
|---|---|---|
| Small | | |
| Intermediate | | |
| Large | | |

Table C 2, Hazard Potential for Risk Analysis

| | Loss of life | Economic Loss |
|---|---|---|
| Low | none | |
| Significant | few | |
| High | more than few | |

## 2. List of Dams for Hazard Identification

Dam Break Analysis is done for all dams regardless of dam size, to produce flood hazard maps.

## 3. Hazard Potential Classification

The main modes of dam failure are dam overtopping, structural instability and foundation failure.

These modes often linked to factors like poor design, poor construction and insufficient maintenance, extreme weather, or geological conditions, can result in catastrophic floods, property damage and loss of life.

Ranking of dams should be based on number of human lives at risk.

IWUMD made (94) dams and DHPI (3)dams for dam break analysis.

Ranking is made only on Large Dams with High Hazard Potential.

# Part III; Assessment on Flood

1. Safety Design for Design Flood

ICOLD bulletin No. (82) Selection of Design Flood

Table C 3, Recommended Safety Standards for Design Flood

| Hazard | Size | Safety Standards |
|---|---|---|
| Low | Small<br>Intermediate<br>Large | |
| Significant | Small<br>Intermediate<br>Large | <br><br>PMF |
| High | Small<br>Intermediate<br>Large | <br>PMF<br>PMF |

## 2. Inflow Design Floods

In Myanmar, inflow design floods varies from 50-year to 1000-year return periods. The 10000-year design flood is rare.

Earthen dams are vulnerable to dam overtopping.

## 3. The July 2015 Flood and September 2024 Flood

The Government declared State of Emergency in Sagaing division, Chin State, Magwe division and Rakhine state due to the July 2015 flood on 31 July 2015.

Dam overtopping happened at Minmyin dam on 18 July 2015 due to a maximum daily rainfall of 10.66 inches on the same day. It is concluded 10000-year flood though design flood frequency is 1000-year .

The main reason of July 2015 flood was the low-pressure trough line across over Myanmar, formed on 5 July 2015, in connection with four typhoons from the South China Sea and some low-pressure cells from India.

The Komen cyclone made landfall in Bangladesh on 30 July 2015.

The September 2024 flood was due to the maximum daily rainfall of 11.89 inches at Thazi (Hlaingtet) and 11.22 inches at Yamethin on 11 September 2024. The main reason was the Yagi typhoon from the Pacific Ocean and a tropical depression from the Bay of Bengal. The two different air masses came together in Thazi and Yamethin area, and forming a training storm. Multiple thunder storms repeatedly developed, moved over the same area and caused prolonged and heavy rains in the same area.

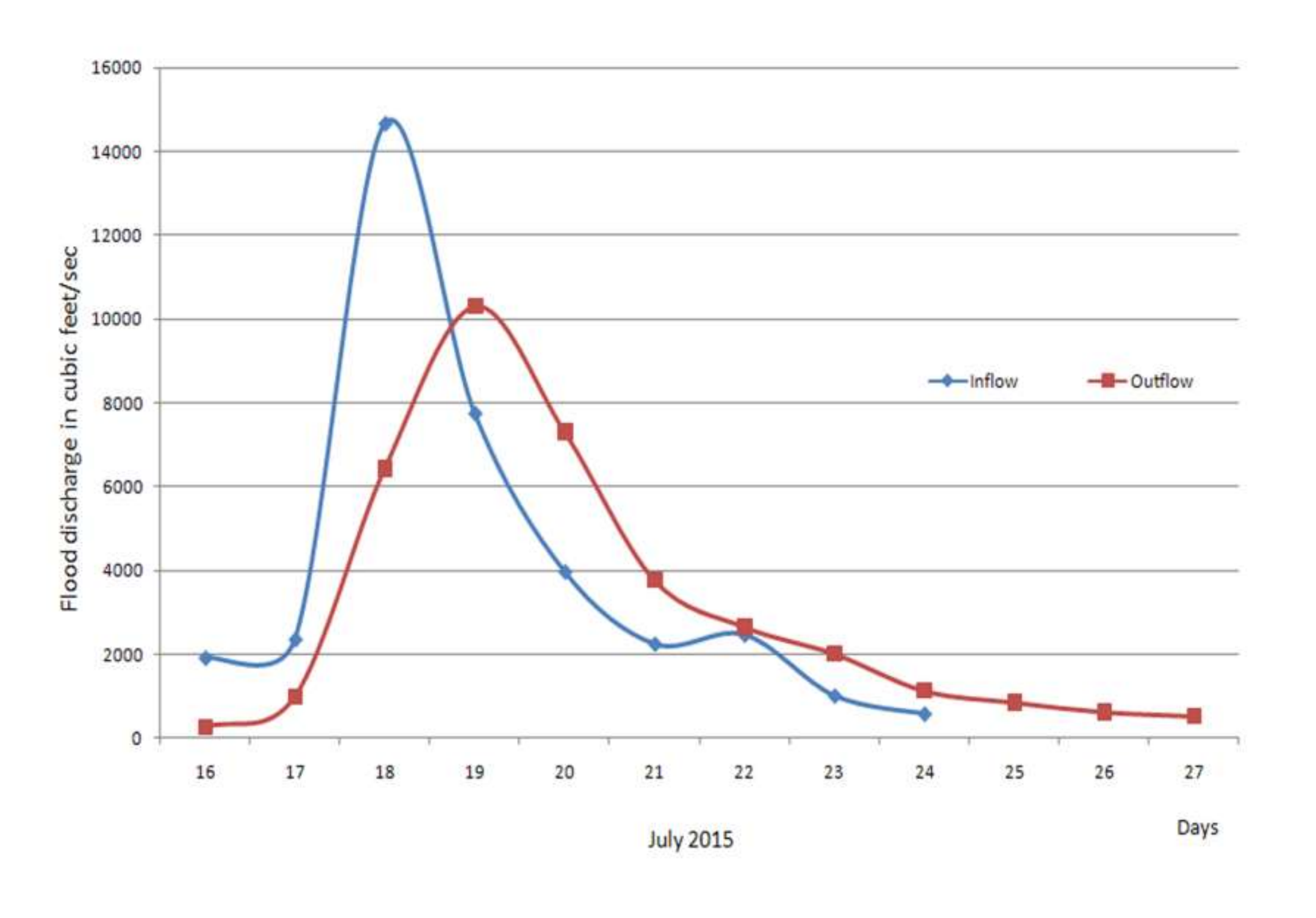
Dam overtopping occurred at Samon retention dam and Kintha dam on 11 September 2024.

The impacts of storms are intensified due to global climate change.

Even though dam overtopping is not happening in other dams, reservoir water level is going up beyond the design high flood level.

Hourly gauge readings during floods is important for inflow flood volume, highest water level, peak discharges of inflow and outflow floods and duration of flood. These data could be known from inflow and outflow hydrographs by flood routing of these hourly gauge readings during floods.

The water level gauge is normally installed on the dam up to the design high flood level. If the water level is rising beyond the design flood level, some gauges must be spared at the dam site.




INFLOW / OUTFLOW HYDROGRAPHS OF MINMYIN DAM

## 4. List of Dams for Flood Assessment

In Myanmar, spillways are mostly designed with the inflow design flood of 1000-year return period.

PMF is seldom used as a safety check flood.

The Thapanseik and Shwegyin dams are selected to check safety with PMF as a safety check flood.

## 5. Examples of Safety Check Floods

The Yeywa dam spillway is designed with 10,000-year flood, but checked with a safety check flood of PMF.

The Upper Paunglaung dam spillway is designed with 1,000-year flood, but checked with PMF.

# Part V; Assessment of Earthquake

## 1. Design Earthquakes

ICOLD Bulletin No. 72 recommends the biggest earthquake in the past in the region as Maximum Credible Earthquake (MCE).

PGA is calculated by putting the magnitude and distance from source in the Ground Motion Predicting Equation (GMPE), based on Deterministic Seismic Hazard Analysis (DSHA).

Another PGA is calculated by Response Spectrum Analysis, by taking 10,000-year earthquake for Large Dam with High Hazard Potential as a Maximum Design Earthquake (MDE), based on Probabilistic Seismic Hazard Analysis (PSHA). It is equivalent with the earthquake in 1 percent exceedance in 100 years.

The bigger PGA, from MCE and MDE, is taken as Safety Evaluation Earthquake (SEE) for dam design.

For dam appurtenant structures, PGA is calculated by Response Spectrum Analysis, by taking 475-year earthquake for Large Dam with High Hazard Potential as an Operating Basis Earthquake (OBE) based on Probabilistic Seismic Hazard Analysis (PSHA). It is equivalent with the earthquake in 2 percent exceedance in 50 years.

# Response Spectrum Analysis

- Earthquake Response Spectra with either acceleration or velocity or displacement in vertical axis
- Either selected earthquake or earthquakes with different intensities to form envelope
- Single-degree-of-freedom (SDOF) with different periods with 5 percent damping

Period = The length of a full cycle of the wave (seconds)

Frequency = 1/period

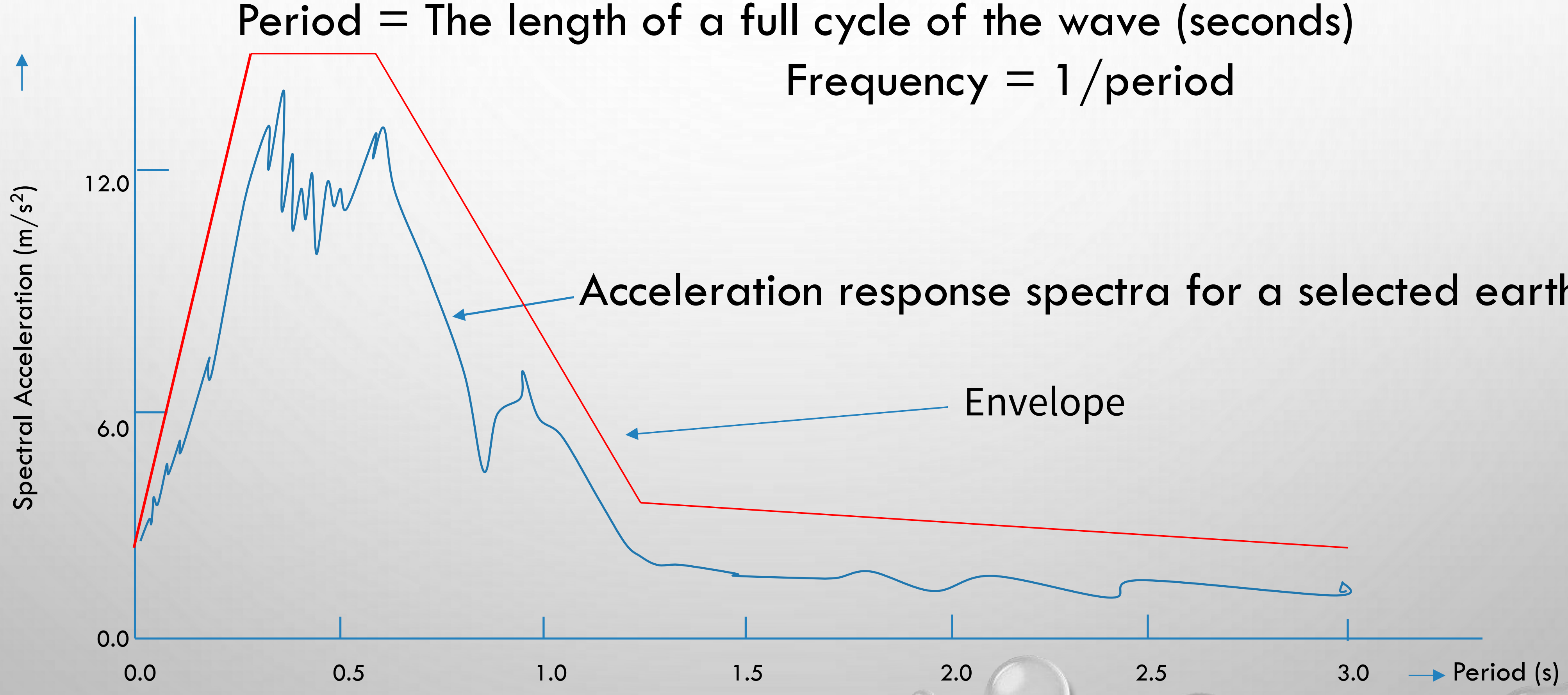



Fig. 5 Acceleration Response Spectra

## 2. Seismic Zone Map of Myanmar

The Myanmar Earthquake Committee (MEC) developed a seismic zone map of Myanmar in deterministic approach in 2005 (DSHA Map 2005).

The Myanmar Earthquake Committee (MEC) also issued two seismic zone maps in probabilistic approach (PSHA Map 2018) and PSHA Map 2019 based on PGA for 475-year return period.

## 3. List of Dams for Earthquake Assessment

In Myanmar, the biggest ever was M 8.0 Maymyo earthquake struck in 23 May 1912. At that time no dams existed around this area.

This earthquake is taken as Maximum Credible Earthquake (MCE) and made assessment on the followings;

1. Thapanseik
2. Se Taw Gyi
3. Yeywa
4. Myogyi
5. Kinda
6. Upper Paunglaung
7. Lower Paunglaung

## 4. The March 2025 Mandalay Earthquake

On 28 March 2025, a destructive strong $M_w$ 7.7 struck at 12:51 pm. The source of earthquake is right-lateral strike-slip Sagaing fault. The epicenter was at the Yega In at 10 km depth. A long duration of 85 seconds and wide spread ground shaking were felt in the region. Its intensity was IX (Violent) on the Modified Mercalli Scale. Synthetic Aperture Radar (SAR) pixel offset data reveals approximately 460 km rupture with 3.5 m of average slip and super shear propagation at 4.8 km/s. The $M_w$ 6.4 aftershock struck after 12 minutes of mainshock.

This strong earthquake had affected on some dams and weir in Mandalay division, Union region and Bago division.

The Ex-Irrigation Personnel Association (EIPA) and MNCOLD had a joint inspection on dams and weir in Mandalay division, Union region and Bago division from 3 to 9 April 2025.

MNCOLD also inspected on some hydropower dams in Mandalay division, Union region and Bago division from 13 to 17 May 2025.

# Some Highlighted points of Dam Inspection

## Yenwe Dam

Some transverse cracks at the both abutments.

Liquefaction occurred due to 55 feet thick sand foundation underneath the dam.

## Yan Aung Myin Dam

Water level was rising beyond rock toe and seepage flow at the downstream of dam.

Piping through dam foundation occurred.

## Chaungmagyi Dam

Transverse cracks on the dam crest.

Liquefaction occurred due to silty sand foundation at the river channel.

## 4. High Ground Acceleration Measurements of Strong Earthquake

The measurement of high ground acceleration at the Nay Pyi Taw DMH/GEOFON station was 0.635 g.

The measurement of high ground acceleration of seismometer on the dam crest of Upper Paunglaung dam was 0.145 g. The design PGA is 0.25 g.

# Part V; Priority List in High Hazard Potential

1. Risk Analysis

There are three parts in Risk Analysis.

(1) Risk Assessment (Hazard Identification)

(2) Risk Communication (Exchange of Information Involving Risk)

(3) Risk Management (Policies and Management Decisions on Risk)

## Risk Assessment

This assessment has already been mentioned in Part II.

## Risk Communication

This procedure is mentioned in the Emergency Preparedness Plan (EPP) of each dam.

## Risk Management

According to the assessments for flood and earthquake, some dams may be safe but some may not be. In that case, decision making is essential for what kind of improvement to be provided and to what extent, and which one is to be given priority.

## 2. Priority List of Large Dams Based on Ranking

As improvement of dams is costly and impossible to conduct for all dams simultaneously and priority must be given for improvement. This priority list of large dams by ranking will be supportive in the decision-making process.

## 3. List of the Largest Storage Dams

Among total 16 numbers, only seven of the largest storage dams have been assessed.

| Dam | Capacity (ac-ft) | Dam | Capicity (ac-ft) |
|---|---|---|---|
| 1. Thapan Seik | 2,880,000 | 9. Mone Chaung | 674,400 |
| 2. Yeywa | 2,114,040 | 10. Mobye | 670,034 |
| 3. Shwegyin | 1,685,000 | 11. Phyu Chaung | 632,533 |
| 4. Upper Paunglaung | 1,368,000 | 12. Lower Paunglaung | 549,420 |
| 5. Kun Chaung | 955,000 | 13. Zawgyi (2) | 517,863 |
| 6. Yenwe | 931,800 | 14. Kyeeon-Kyeewa | 463,000 |
| 7. **Kabaung** | **878,785** | 15. **Se Taw Gyi** | **363,000** |
| 8. **Kinda** | **873,580** | **16. Thauk Yegat (2)** | **360,000** |

# Part VI; Conclusion

This report of Flood and Earthquake Risk Assessment for Dams in Myanmar by MNCOLD will be helpful for improving dams in Myanmar.

Thank You for Your Kind Attention !