Dam Break Analysis, Mapping and Emergency Action Plan

EGAT

EGAT

When it happened

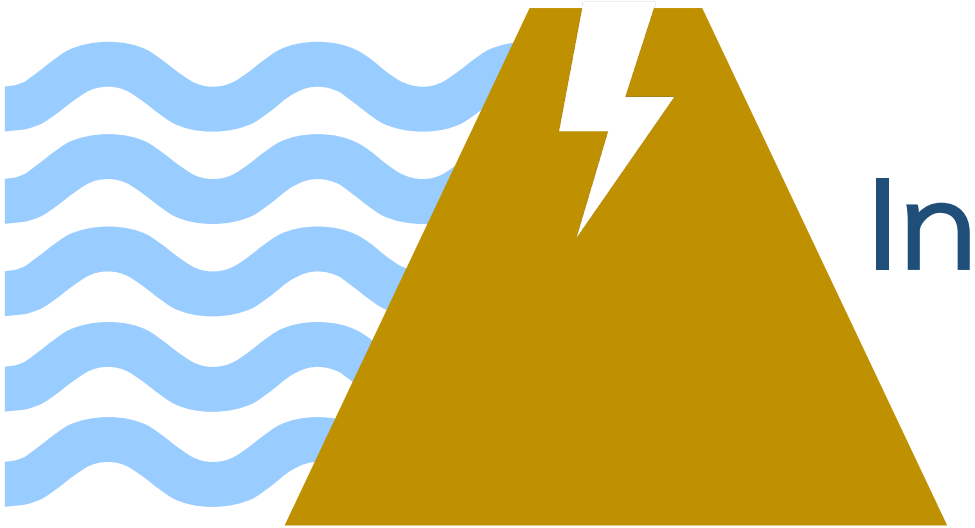






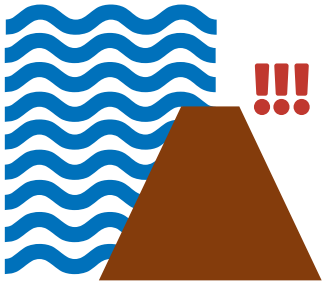
EGAT's Emergency Action Plans





Incidents related to DAM

Dam Incident



Overtopping



Operational Releases

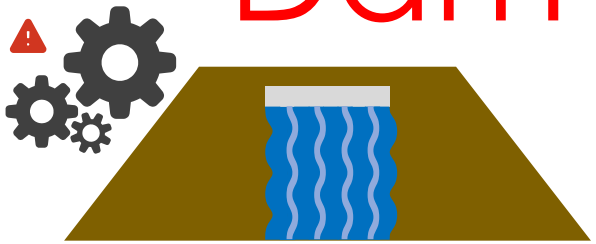


Malfunctions

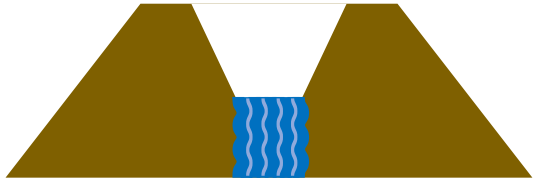


Low Pool Elevation

Dam Failures



Critical Appurtenant Structure Failure



Dam Breach

Source: FEMA (2019)

EGAT

Emergency Response Plan (ERP)

1990 – 2007

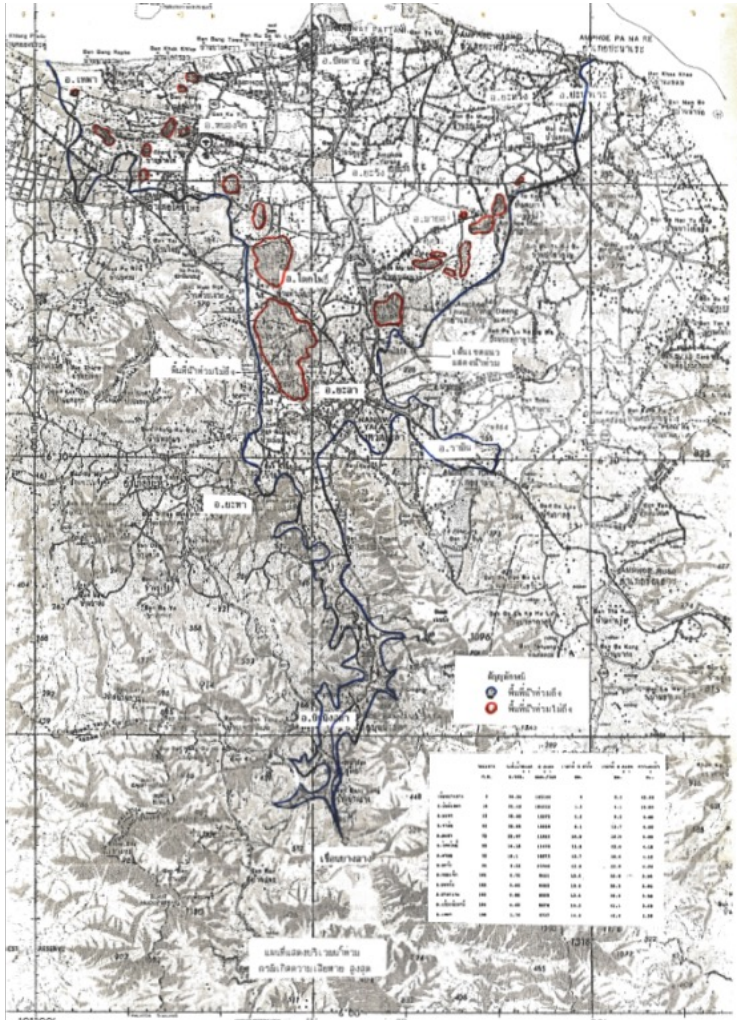
Emergency Preparedness Plan (EPP)

2008 – 2013

Emergency Action Plan (EAP)

2013 – Present

Emergency Response Plan (ERP) 1990 – 2007



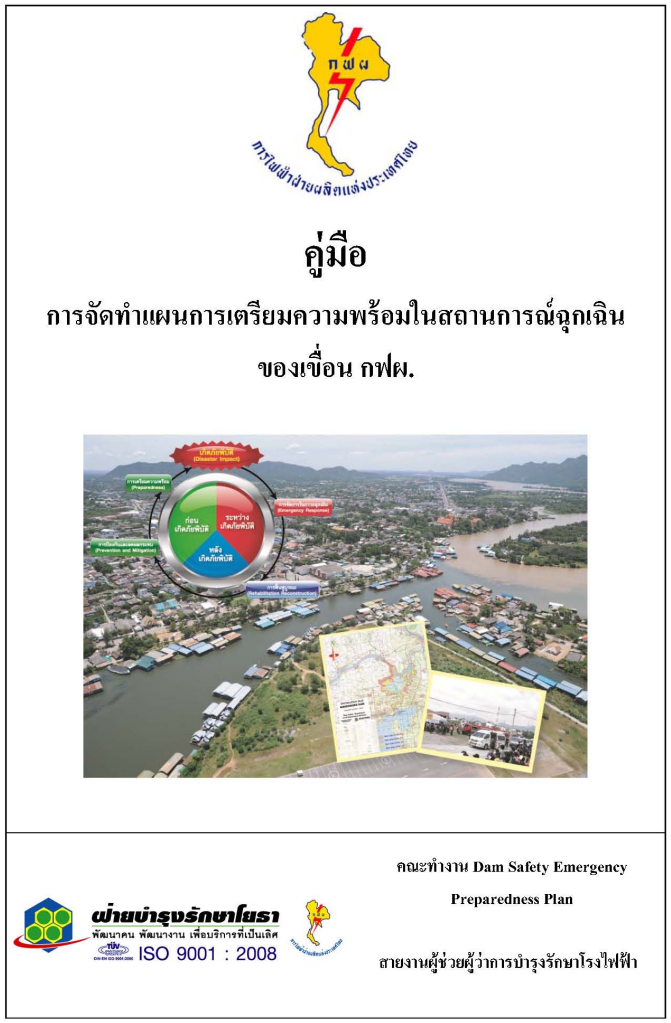
Analyzed dam break by using BOSS DAMBRK

Inundation Boundary

Emergency Organization Chart

Emergency Response Team

Emergency Preparedness Plan (EPP) 2008 – 2013



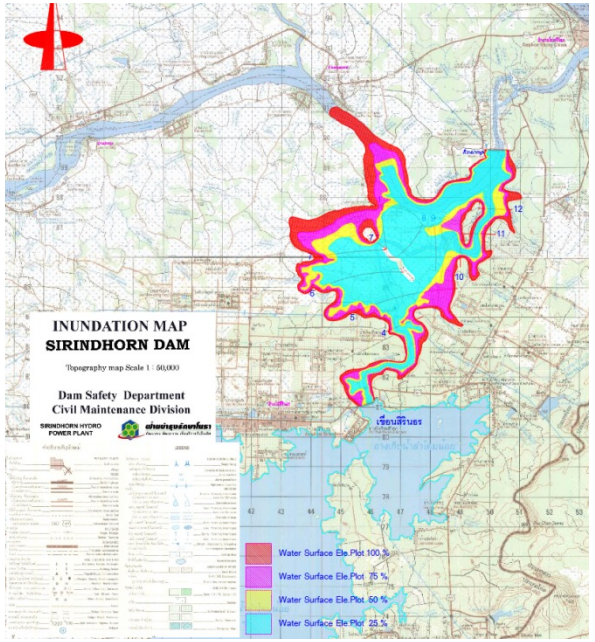
Analyzed dam break by using MIKE 11

Inundation Map *

Emergency Organization Chart

Emergency Response Team

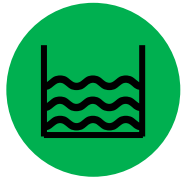
Emergency Level *



Emergency Action Plan (EAP) 2013 – Present

Collaboration  Awareness

Emergency Response Plan 

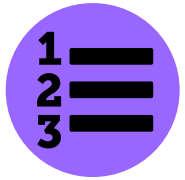
 Data

Emergency Preparedness Plan 

 Dam Break Analysis

DHI MIKE FLOOD

Notification Flowchart and Communication 

 Scenario Analysis

Responsibility 

 Inundation Map and Evacuation Route

Dam Break Analysis

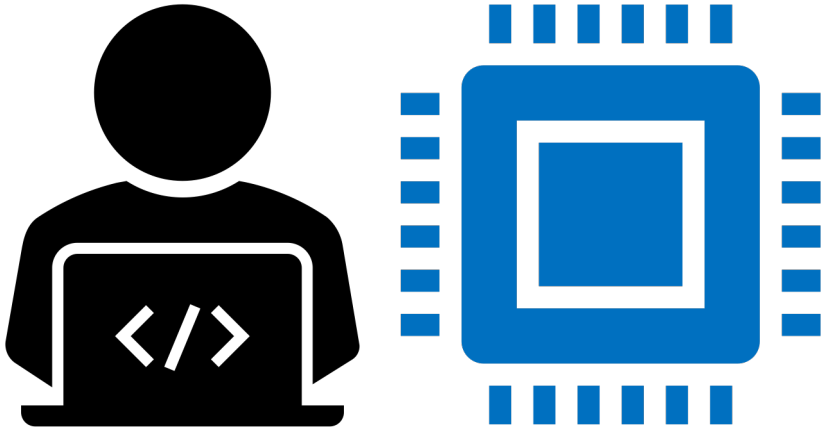
Data



Geographic Information



Dam Property & Hydrologic Historical Data



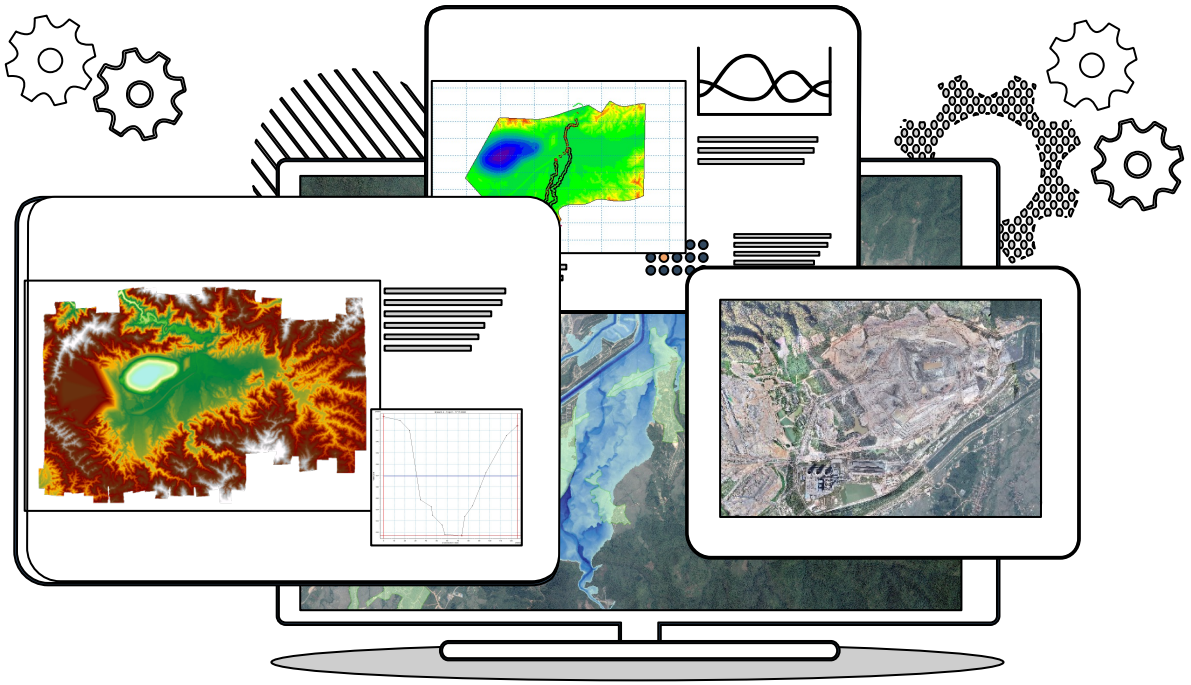
Simulation & Analysis

Data for Analysis

DEM

Orthophoto

River Cross-Section



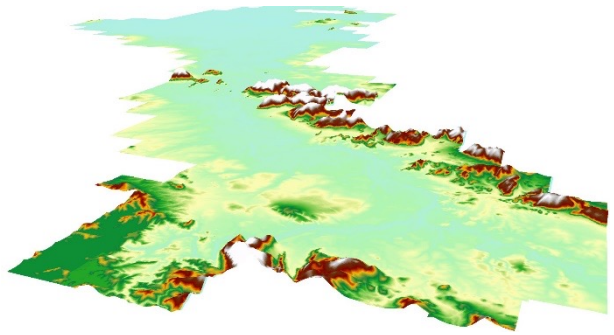
Flood Hydrograph

Dam Property

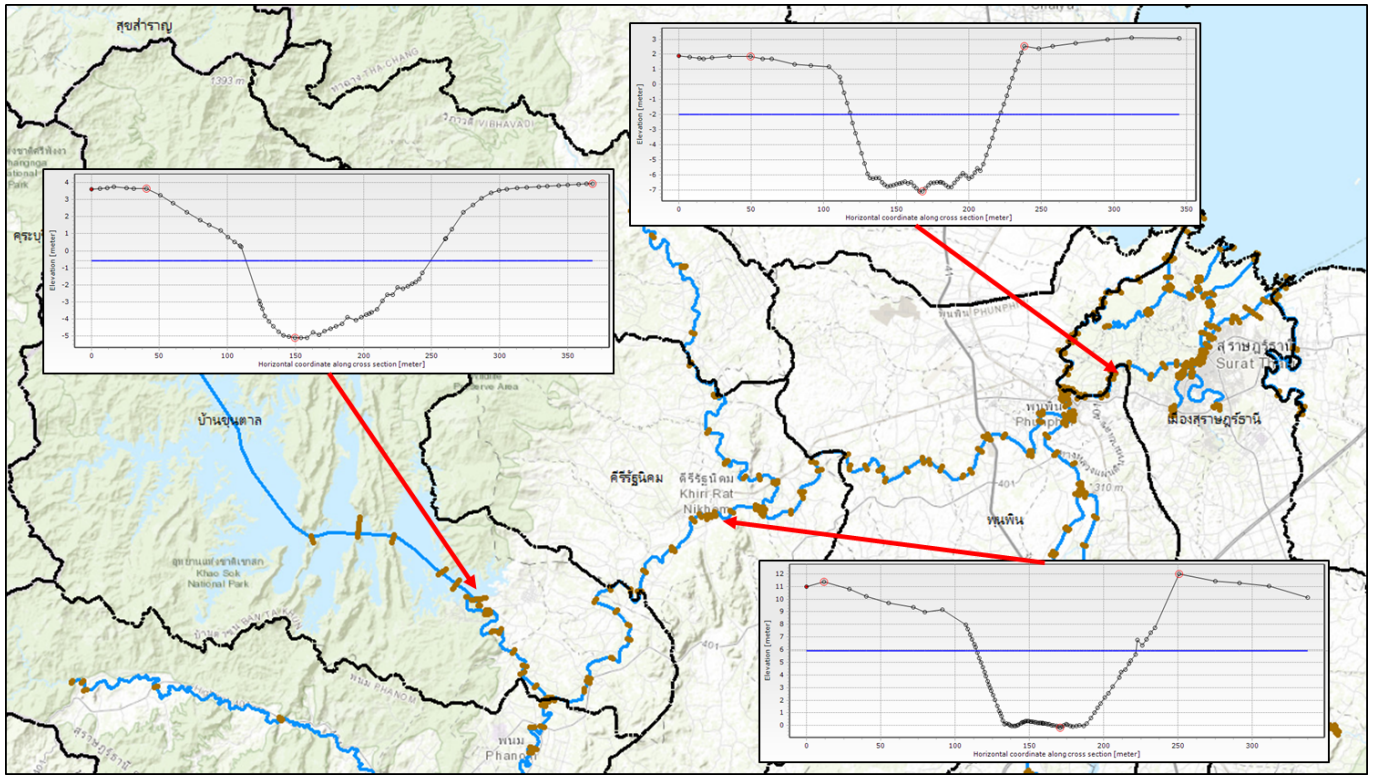
Land Use

Data for Dam Break Analysis





Digital Elevation Model : DEM



Cross-section

Topographic Survey











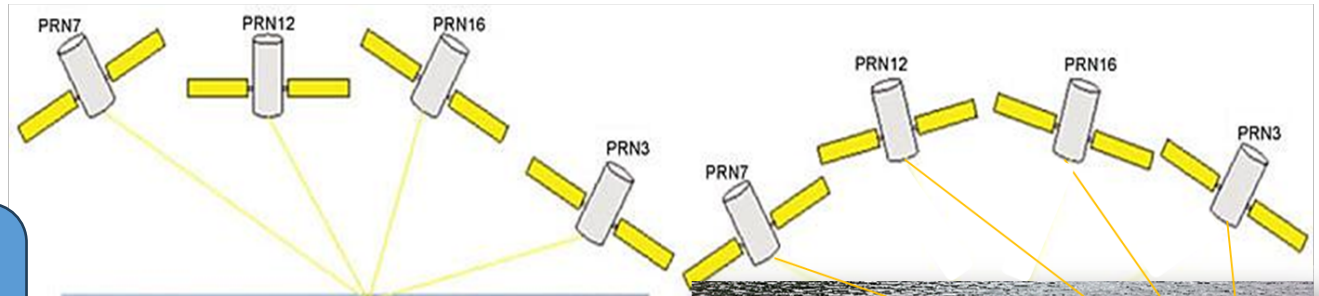
Hydrographic Survey

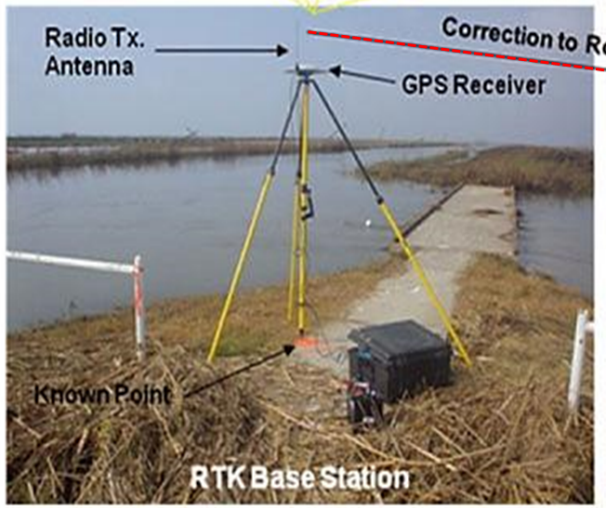




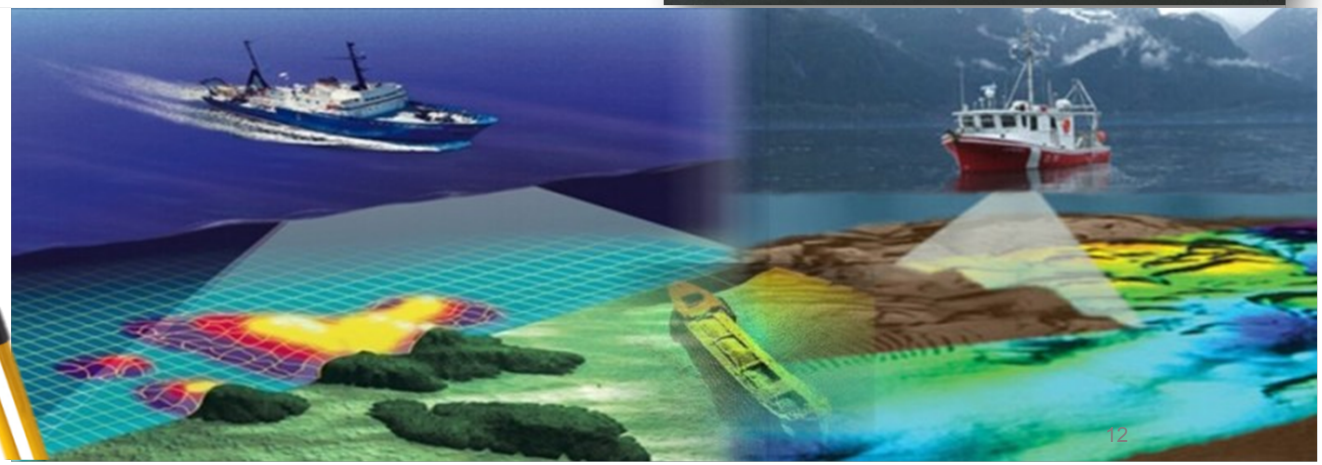










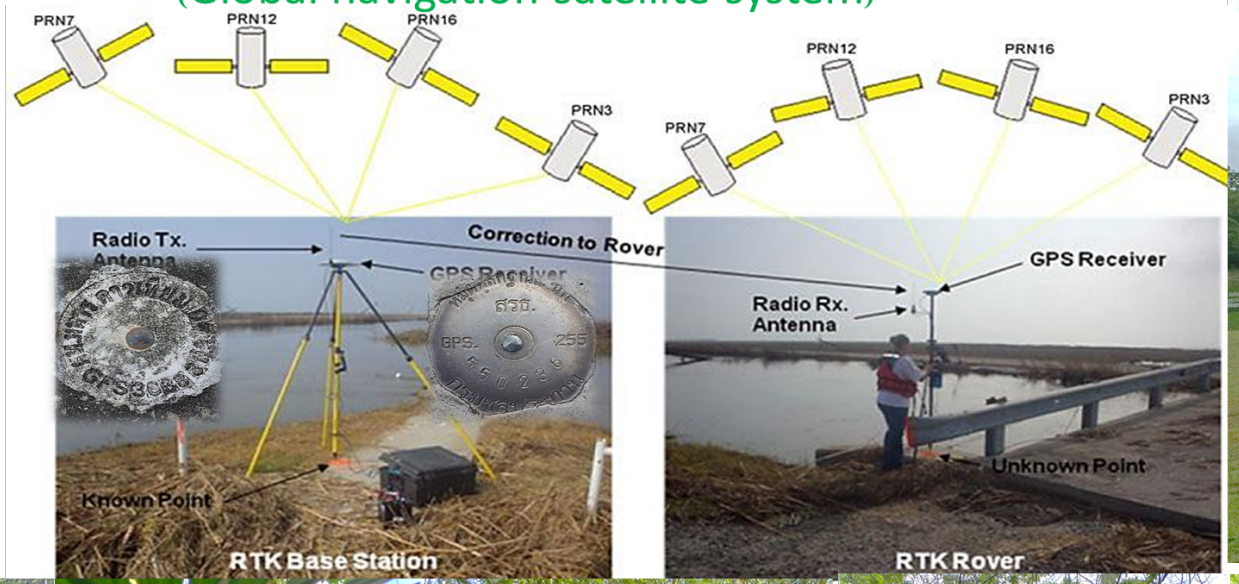


EGAT

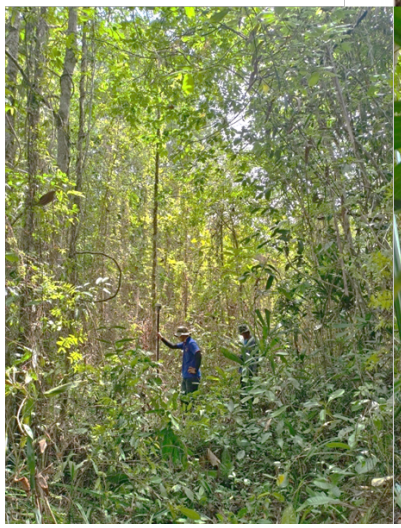
GNSS

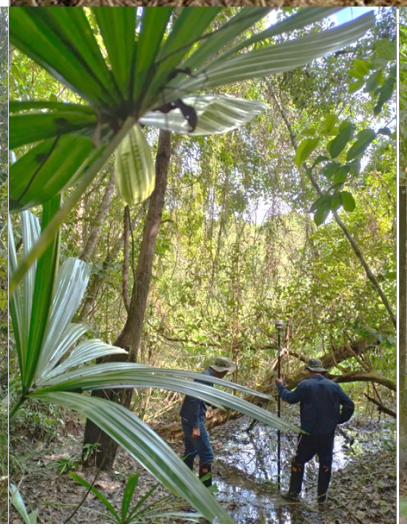
(Global navigation satellite system)











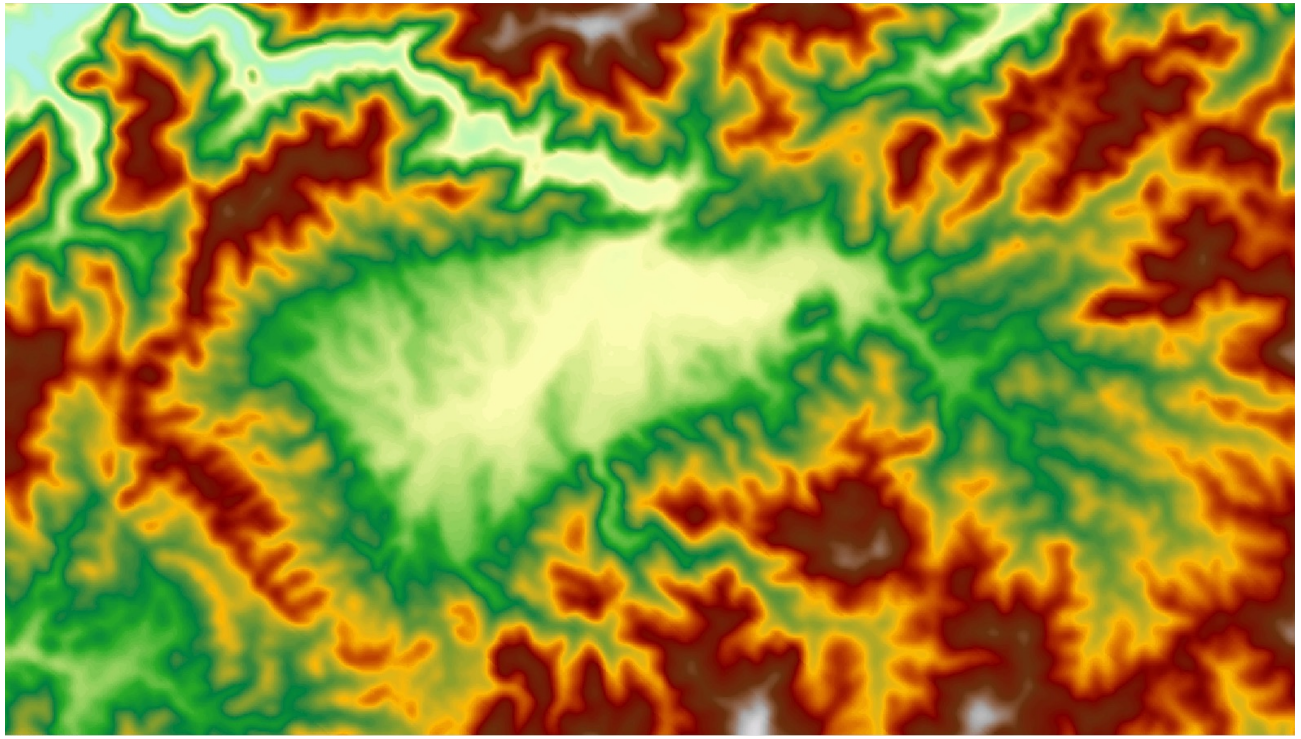




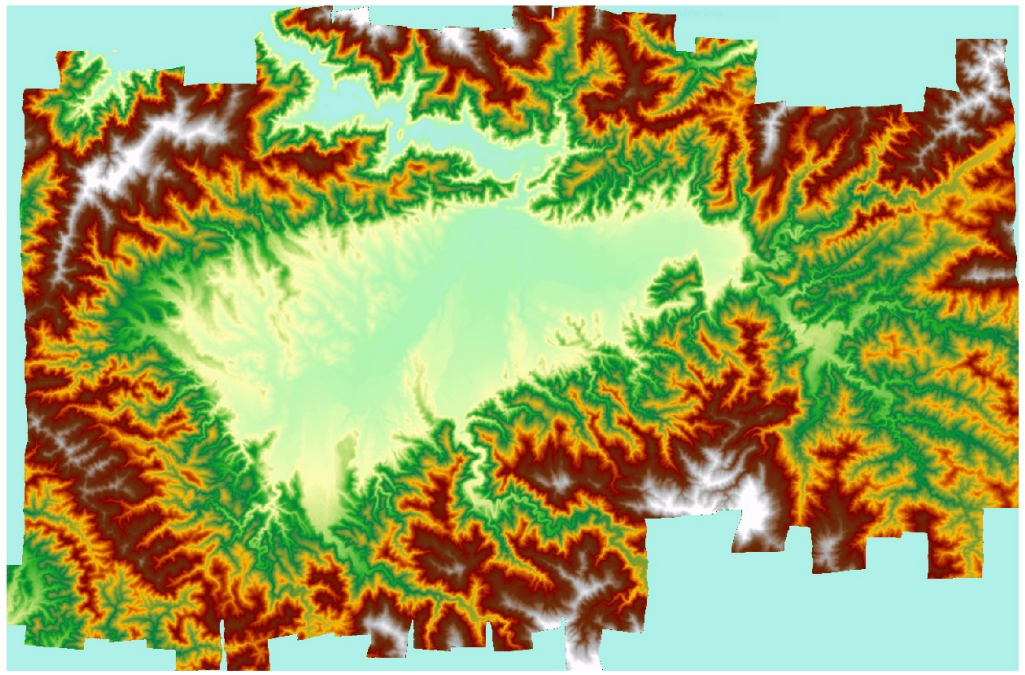




Digital Elevation Model (DEM)



DEM 30x30 m



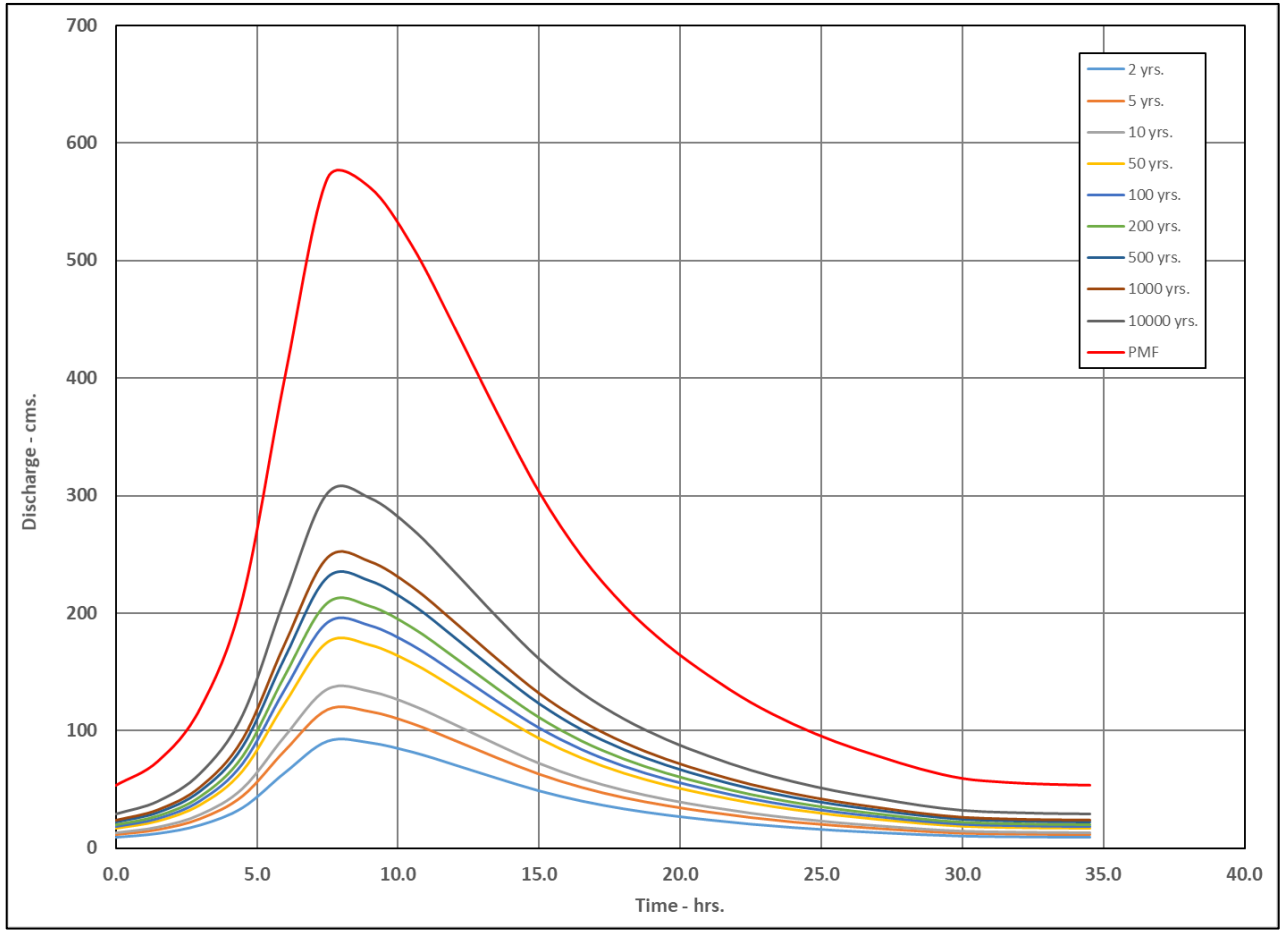
DEM 1x1 m

Flood Hydrograph

Time (hr)	Flood Hydrograph at Nam Luok Reservoir (cms)									
	Return Period (Years)									
	2	5	10	50	100	200	500	1000	10000	PMF
0.0	9.0	11.6	13.3	17.1	18.7	20.2	22.3	23.8	29.0	53.5
1.5	12.3	15.9	18.2	23.4	25.6	27.8	30.6	32.8	40.0	74.2
3	19.5	25.2	28.9	37.2	40.7	44.2	48.8	52.3	63.9	119.3
4.5	34.3	44.5	51.2	66.0	72.3	78.5	86.7	93.0	113.6	213.3
6	64.2	83.2	95.8	123.7	135.5	147.3	162.8	174.5	213.5	401.9
7.5	90.8	117.7	135.6	175.1	191.8	208.5	230.5	247.2	302.5	569.9
9	89.5	116.1	133.7	172.7	189.2	205.7	227.4	243.8	298.3	562.1
10.5	81.6	105.9	121.9	157.5	172.5	187.5	207.3	222.3	272.0	512.3
12	70.7	91.6	105.5	136.3	149.3	162.2	179.3	192.3	235.3	443.0
13.5	59.3	76.8	88.5	114.2	125.1	135.9	150.2	161.1	197.0	370.8
15	48.5	62.9	72.4	93.4	102.3	111.2	122.9	131.7	161.1	302.9
16.5	39.9	51.7	59.5	76.8	84.1	91.3	100.9	108.2	132.3	248.5
18	33.2	43.0	49.5	63.9	69.9	76.0	83.9	90.0	110.0	206.4
19.5	28.0	36.3	41.7	53.8	58.9	64.0	70.7	75.7	92.5	173.5
21	23.8	30.8	35.4	45.7	50.0	54.3	59.9	64.2	78.4	146.9
22.5	20.2	26.1	30.0	38.7	42.3	45.9	50.7	54.3	66.3	124.0
24	17.3	22.3	25.7	33.0	36.1	39.2	43.3	46.4	56.6	105.6
25.5	14.9	19.3	22.1	28.4	31.1	33.8	37.3	39.9	48.7	90.6
27	13.0	16.8	19.3	24.7	27.1	29.4	32.4	34.7	42.3	78.5
28.5	11.3	14.5	16.7	21.4	23.4	25.3	28.0	29.9	36.4	67.5
30	10.0	12.8	14.7	18.9	20.6	22.4	24.7	26.4	32.1	59.4
31.5	9.5	12.2	14.0	17.9	19.6	21.2	23.4	25.0	30.4	56.2
33	9.2	11.8	13.6	17.4	19.0	20.6	22.7	24.3	29.5	54.5
34.5	9.1	11.7	13.4	17.2	18.7	20.3	22.4	24.0	29.1	53.7
Q peak	90.8	117.7	135.6	175.1	191.8	208.5	230.5	247.2	302.5	569.9

Return Period (yrs.)	Max Inflow Flood (cms)	Max Outflow Flood (cms)	Max Elevation (m.MSL)
2	90.80	76.31	633.15
5	117.70	101.94	633.37
10	135.60	118.14	633.51
50	175.10	158.40	633.78
100	191.80	174.66	633.89
200	208.50	190.38	634.00
500	230.50	212.31	634.13
1000	247.20	228.40	634.20
10000	302.50	283.43	634.49
PMF	569.90	540.50	635.70

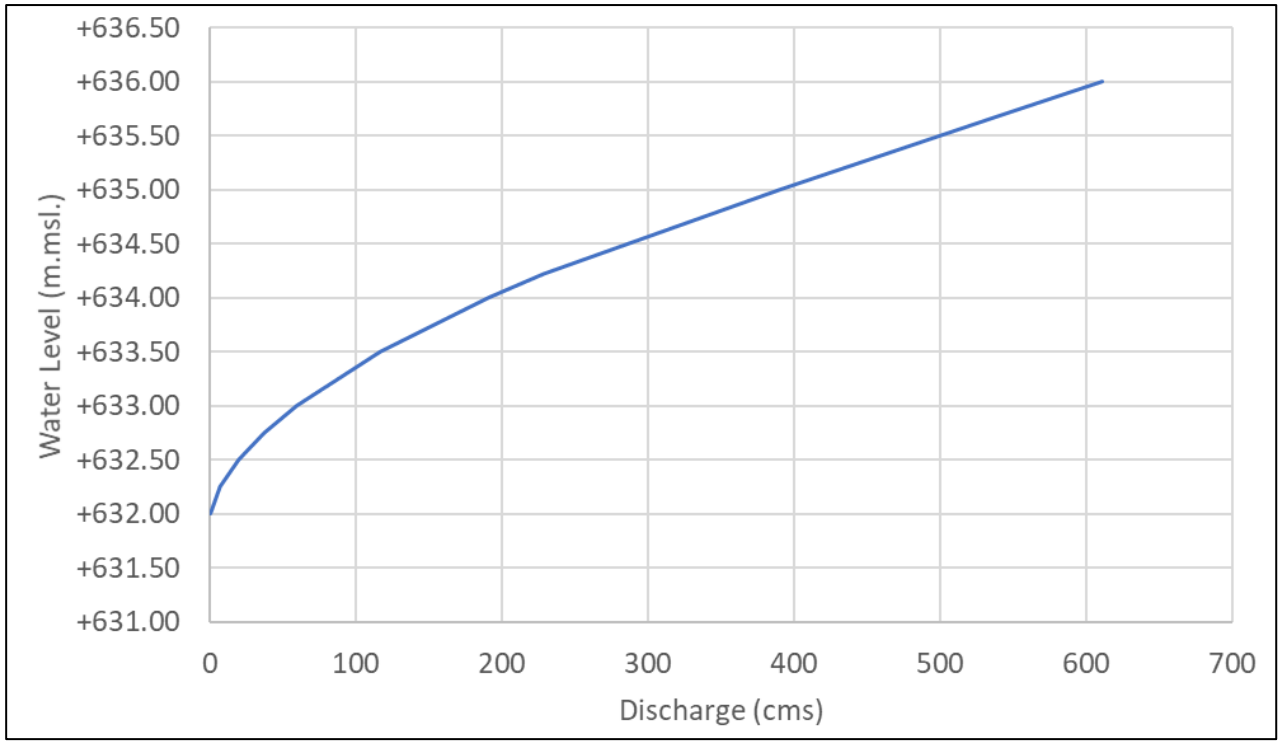
Dam Break Analysis

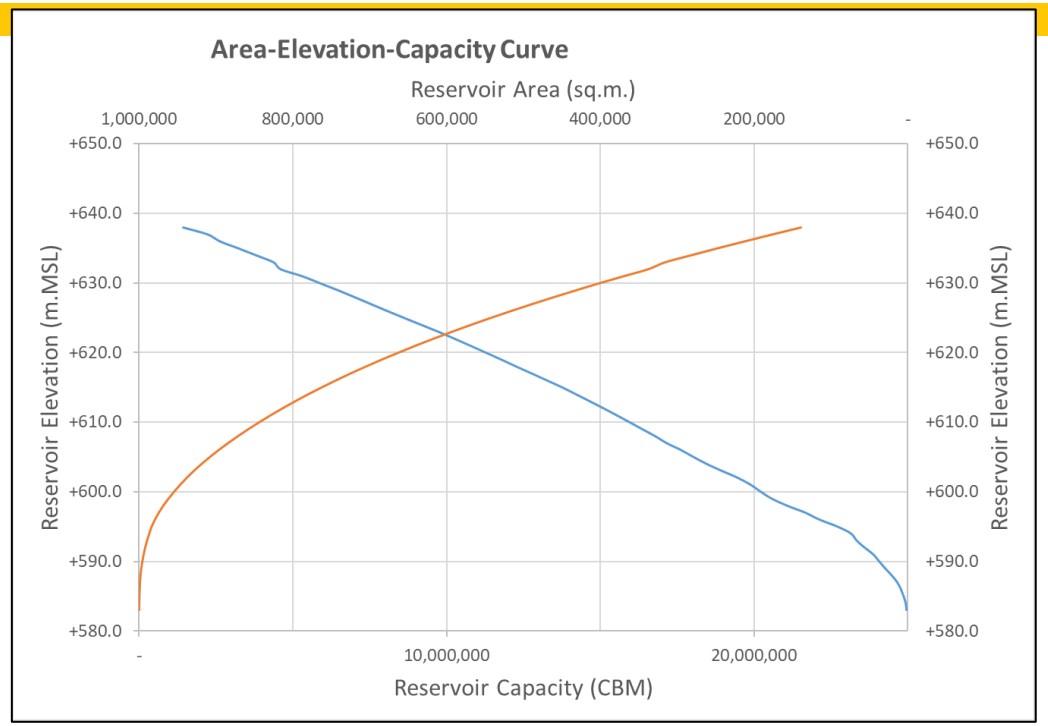


Spillway Discharge

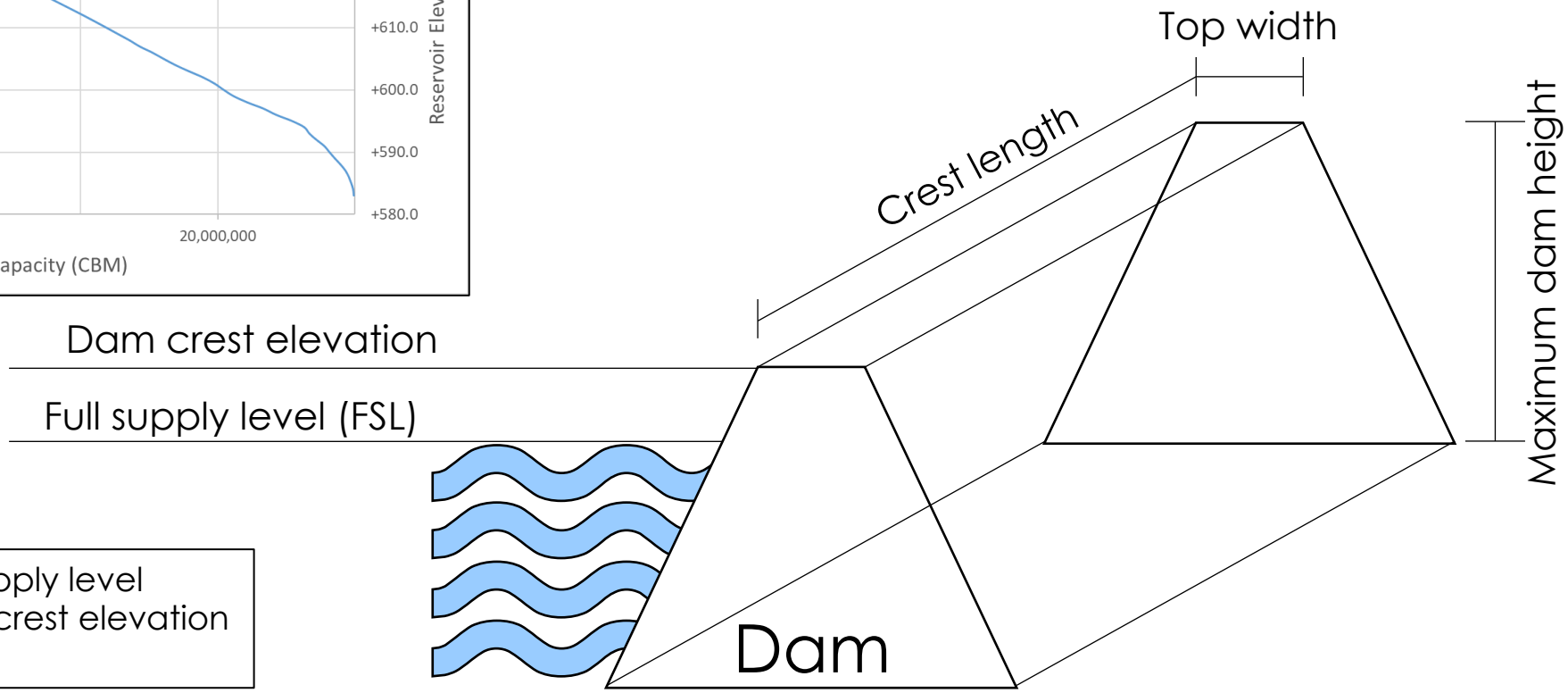
WL (m.MSL)	Outflow (cms)	WL (m.MSL)	Outflow (cms)	WL (m.MSL)	Outflow (cms)	WL (m.MSL)	Outflow (cms)
632.00	0.000	633.00	59.170	634.00	190.599	635.00	390.271
632.10	2.626	633.10	70.626	634.10	207.764	635.10	412.241
632.20	5.252	633.20	82.083	634.20	224.930	635.20	434.212
632.30	9.126	633.30	93.539	634.30	244.969	635.30	456.182
632.40	14.247	633.40	104.996	634.40	265.726	635.40	478.153
632.50	19.369	633.50	116.452	634.50	286.484	635.50	500.123
632.60	26.428	633.60	131.281	634.60	307.241	635.60	522.094
632.70	33.487	633.70	146.111	634.70	327.999	635.70	544.111
632.80	41.448	633.80	160.940	634.80	348.756	635.80	566.372
632.90	50.309	633.90	175.770	634.90	369.514	635.90	588.634
633.00	59.170	634.00	190.599	635.00	390.271	636.00	610.895

Dam Break Analysis





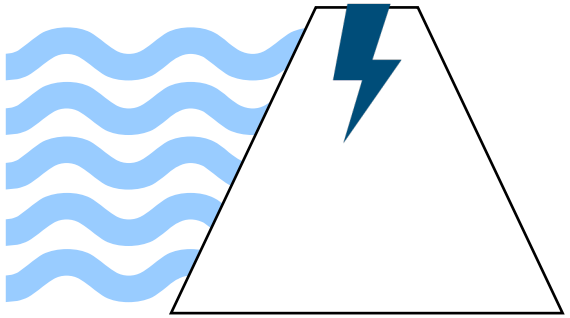
Dam Break Analysis



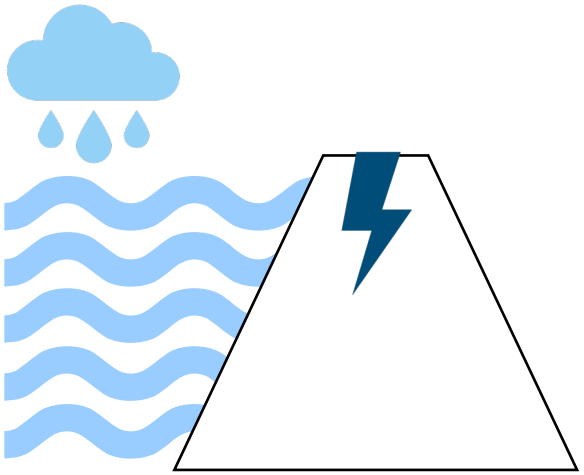
Reservoir capacity at the full supply level
Reservoir capacity at the Dam crest elevation
Spillway design discharge

Dam Break Analysis

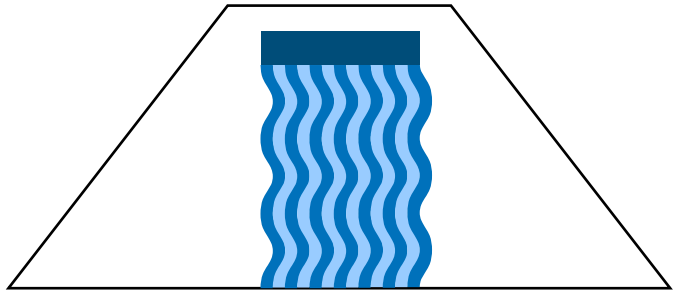
Mode of Failure



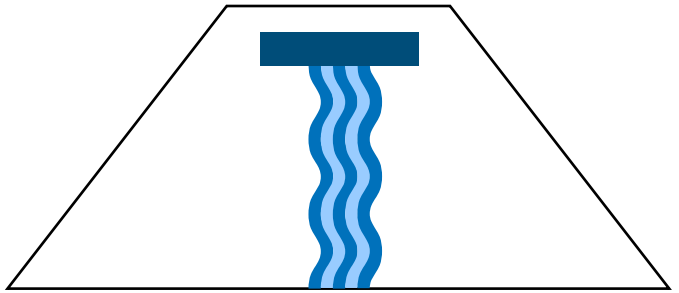
Scenario A
Full Reservoir Level



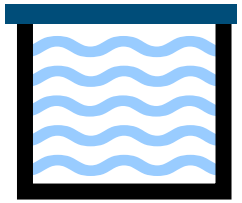
Scenario B
Design Flood



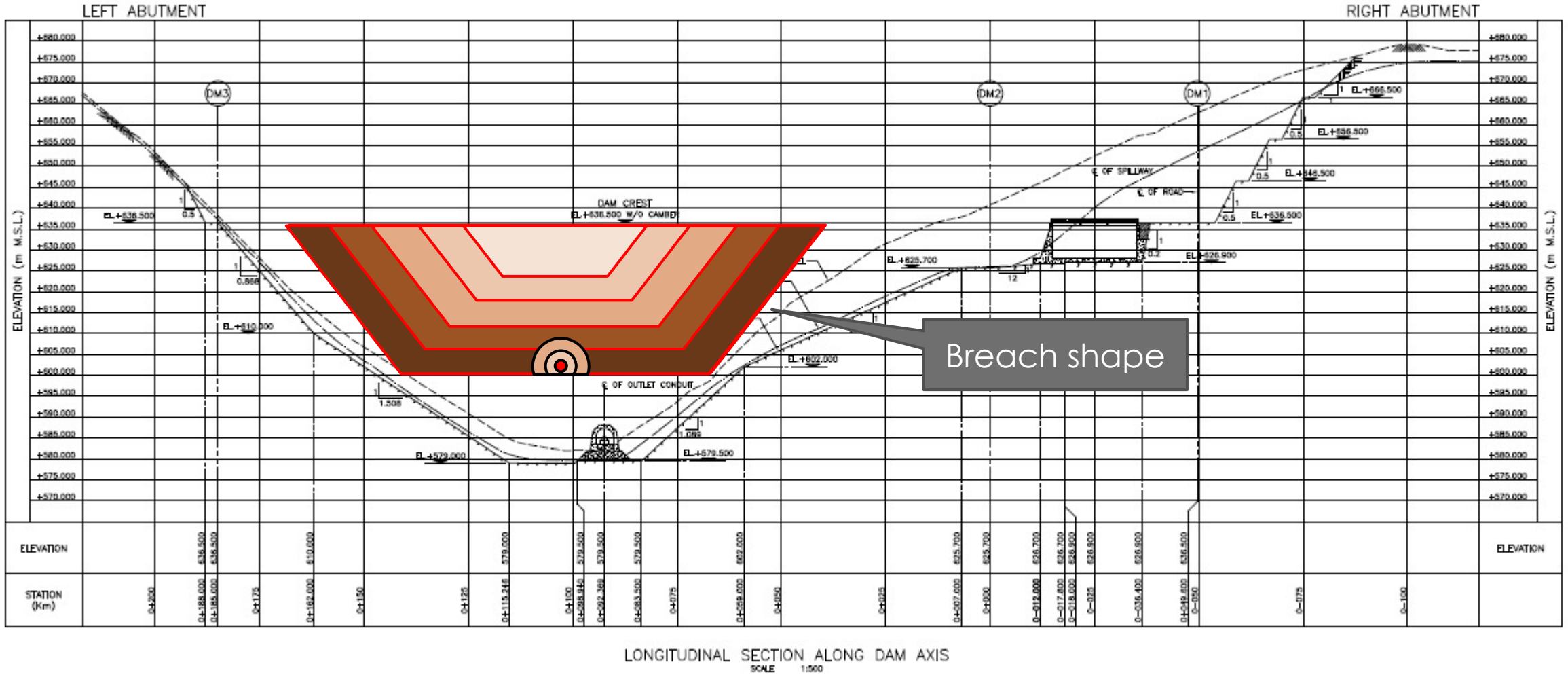
Scenario C
Maximum Release



Scenario D
Safe Discharge

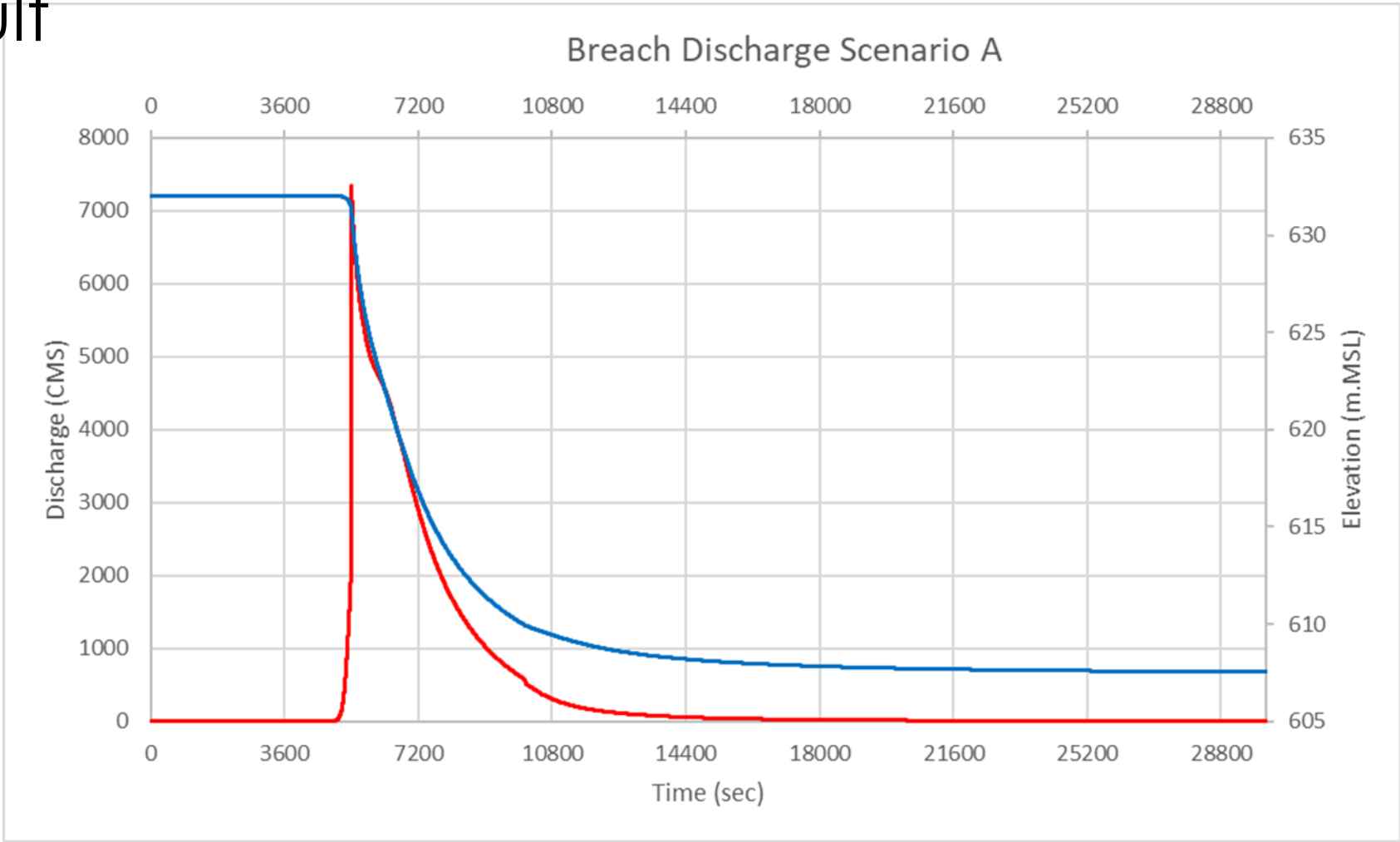


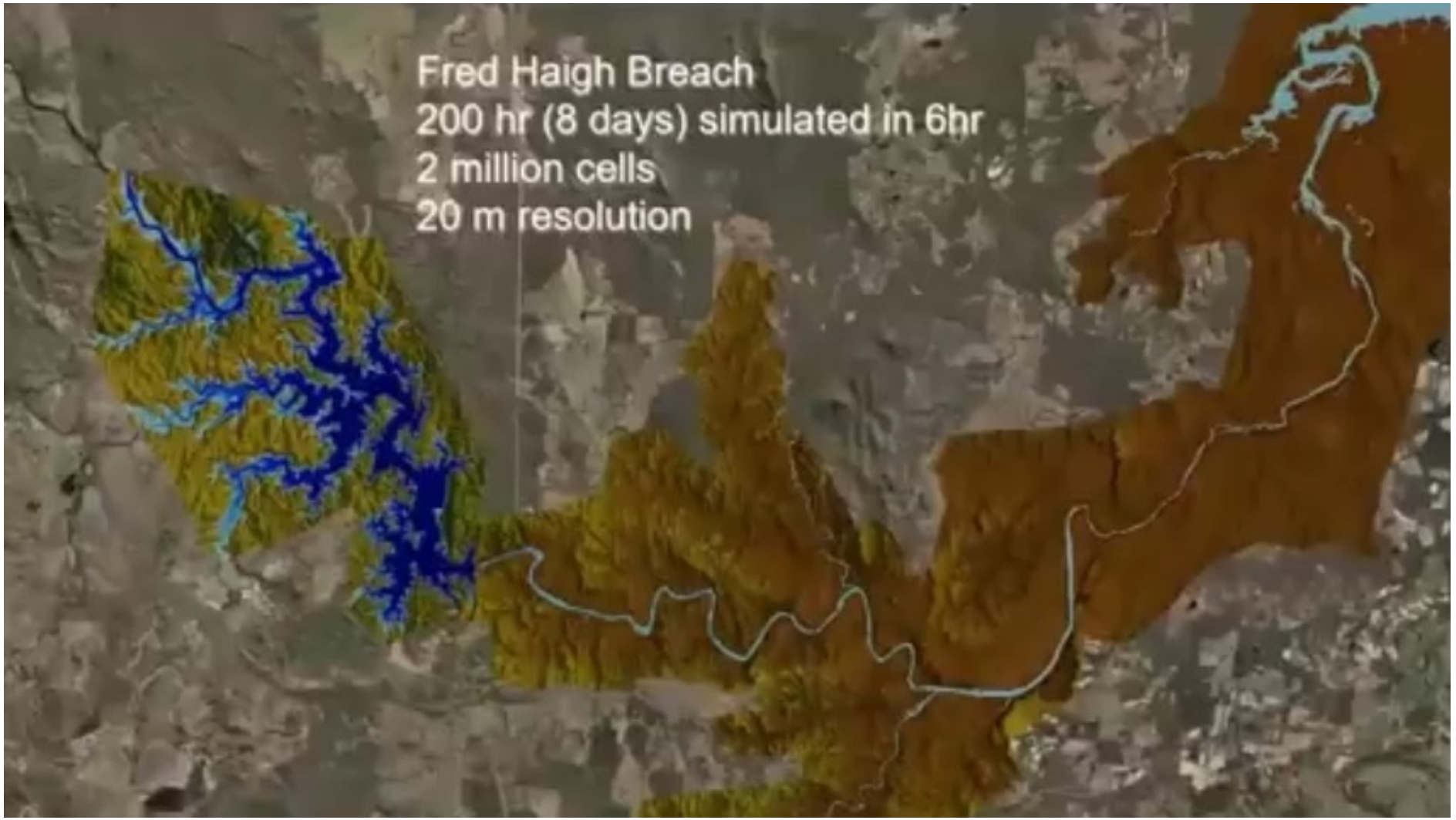
Scenario A


LEFT ABUTMENT
RIGHT ABUTMENT
ELEVATION (m M.S.L.)
DM3
DM2
DM1
DAM CREST
EL.+636.500 W/O CAMBER
EL.+636.500
EL.+610.000
EL.+602.000
EL.+579.000
EL.+579.500
EL.+625.700
EL.+626.900
EL.+666.500
EL.+656.500
EL.+646.500
EL.+636.500
℄ OF OUTLET CONDUIT
℄ OF SPILLWAY
℄ OF ROAD
Breach shape
ELEVATION
STATION (Km)
LONGITUDINAL SECTION ALONG DAM AXIS
SCALE 1:500

Dam Break Analysis

Result





Ref : https://www.youtube.com/watch?v=iRCYmQsWTXA

Inundation Maps



Flood Arrival Time

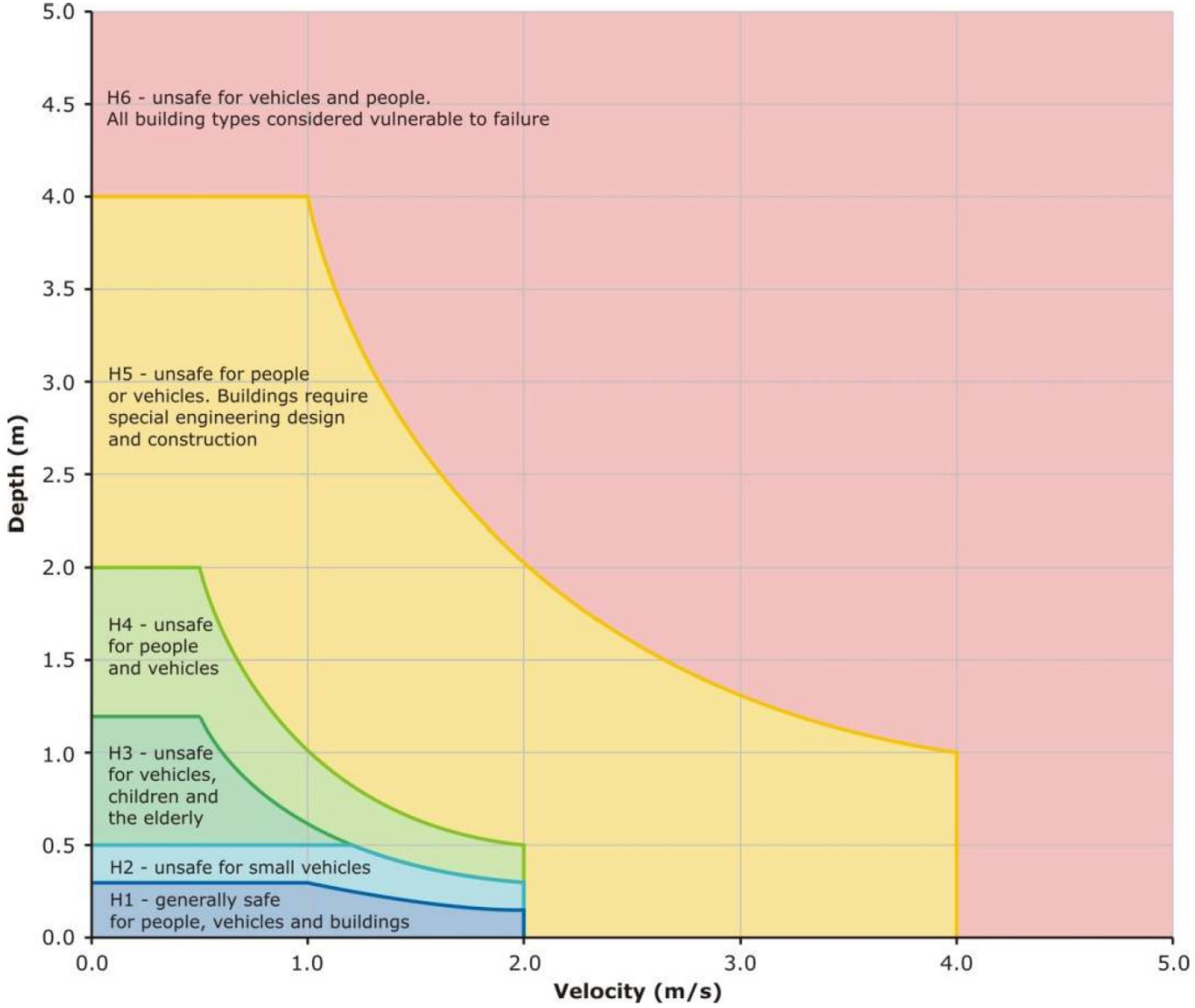


Time to Peak Flood



Maximum Flood Depth

Flood Hazard



Dam Break Analysis

DV

Depth x Velocity (m^2/s)

Reference: Technical Flood Risk Management Guideline: Flood hazard (2017)

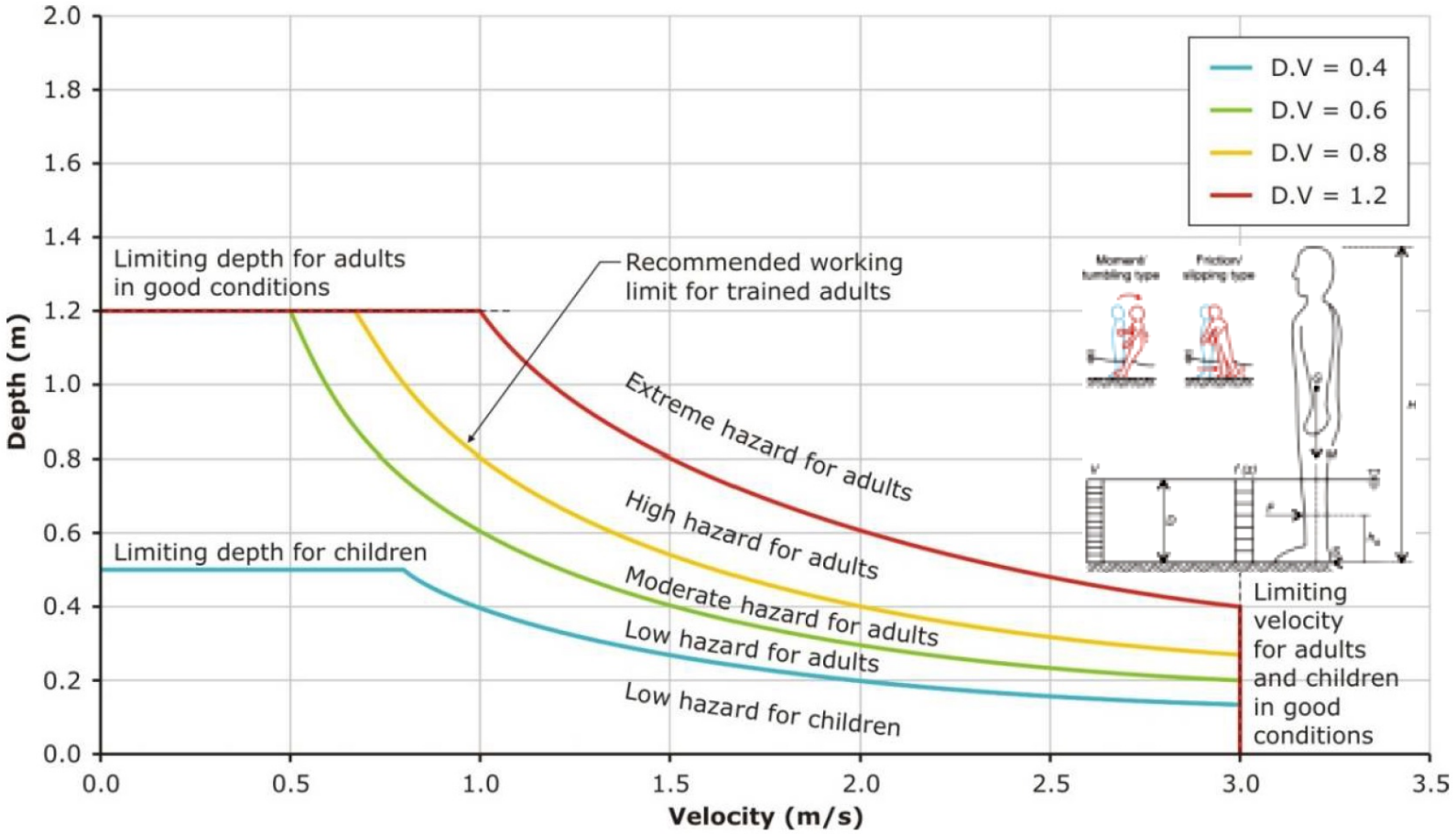
Dam Break Analysis

Flood Hazard	Description	Classification limit	Limiting still water depth	Limiting velocity
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.	DV > 4.0	-	-
H5	Unsafe for vehicles and people. Buildings require special engineering design and construction.	DV ≤ 4.0	4.0	4.0
H4	Unsafe for vehicles and people.	DV ≤ 1.0	2.0	2.0
H3	Unsafe for vehicles, children and the elderly.	DV ≤ 0.6	1.2	2.0
H2	Unsafe for small vehicles.	DV ≤ 0.6	0.5	2.0
H1	Generally **safe** for vehicles, people and buildings. Relatively benign flood conditions. No vulnerability constraints.	DV ≤ 0.3	0.3	2.0

Reference: Technical Flood Risk Management Guideline: Flood hazard (2017)

Thresholds for People Stability in Floods

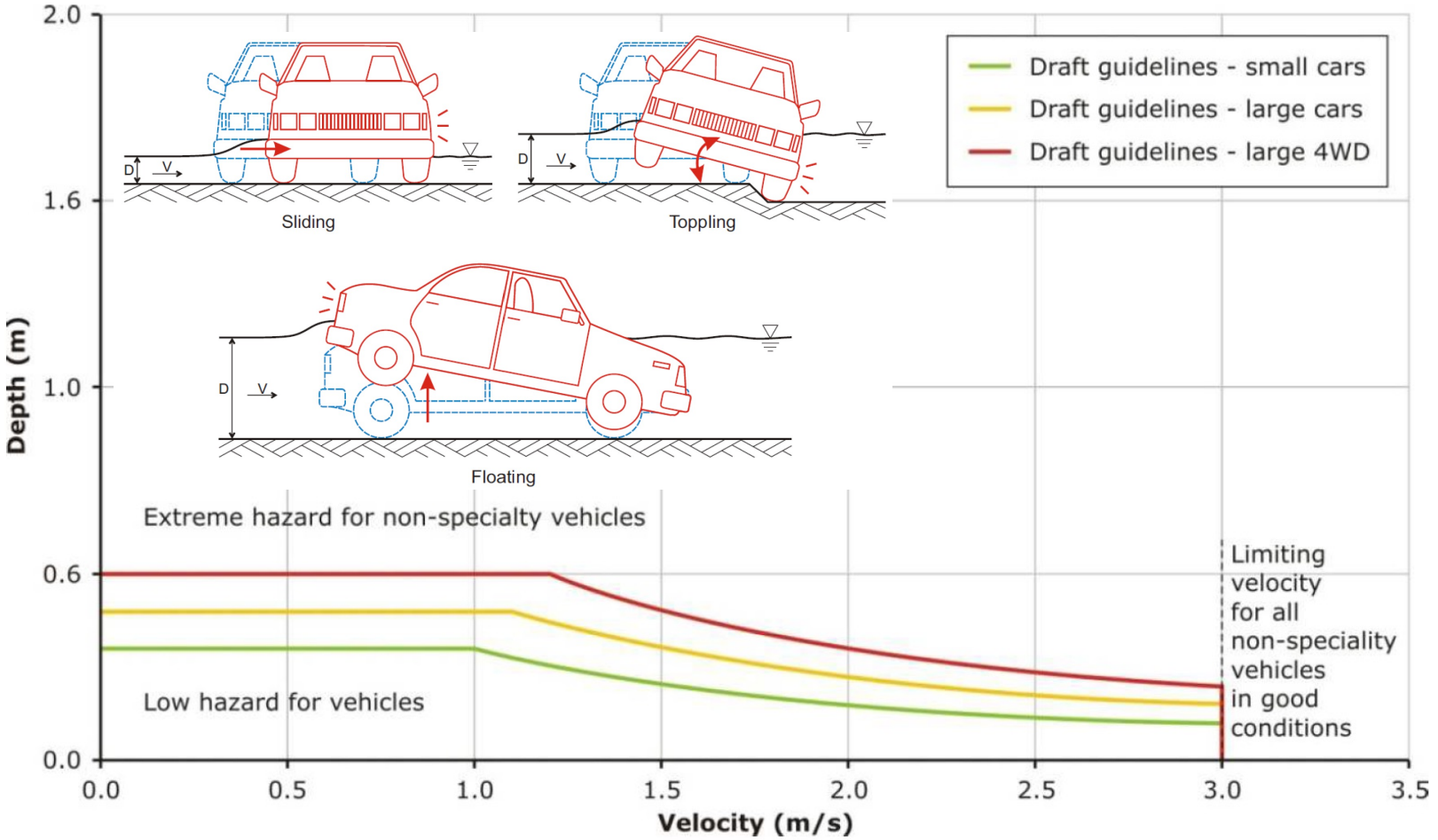
Dam Break Analysis



Reference: Technical Flood Risk Management Guideline: Flood hazard (2017)
Australian Rainfall & Runoff (Project 10): Appropriate Safety Criteria for Vehicles (2011)

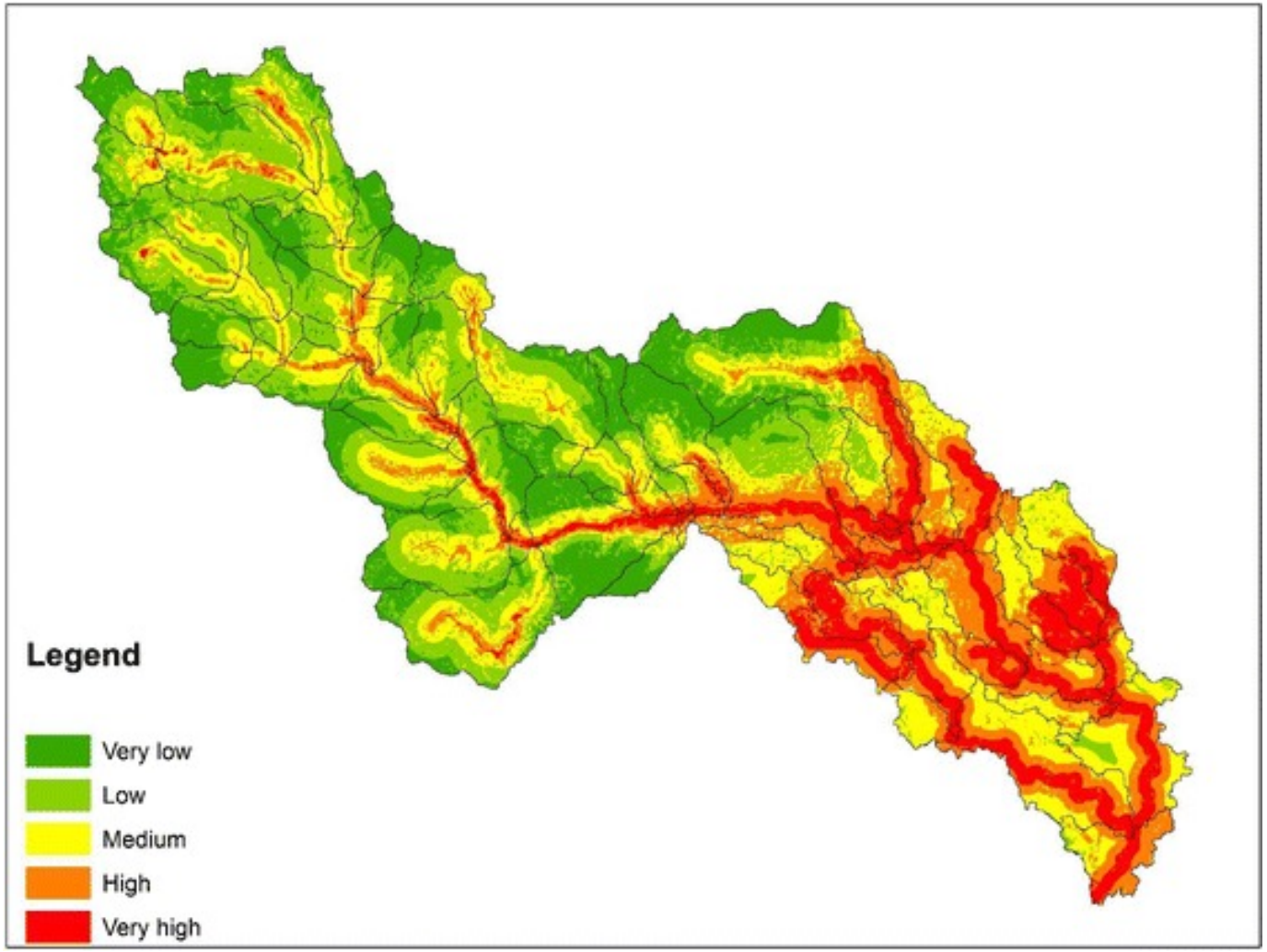
Thresholds for Vehicles Stability in Floods

Dam Break Analysis



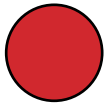
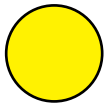
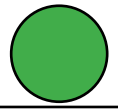
Reference: Technical Flood Risk Management Guideline: Flood hazard (2017)
Australian Rainfall & Runoff (Project 10): Appropriate Safety Criteria for Vehicles (2011)

Example : Flood Hazard Map



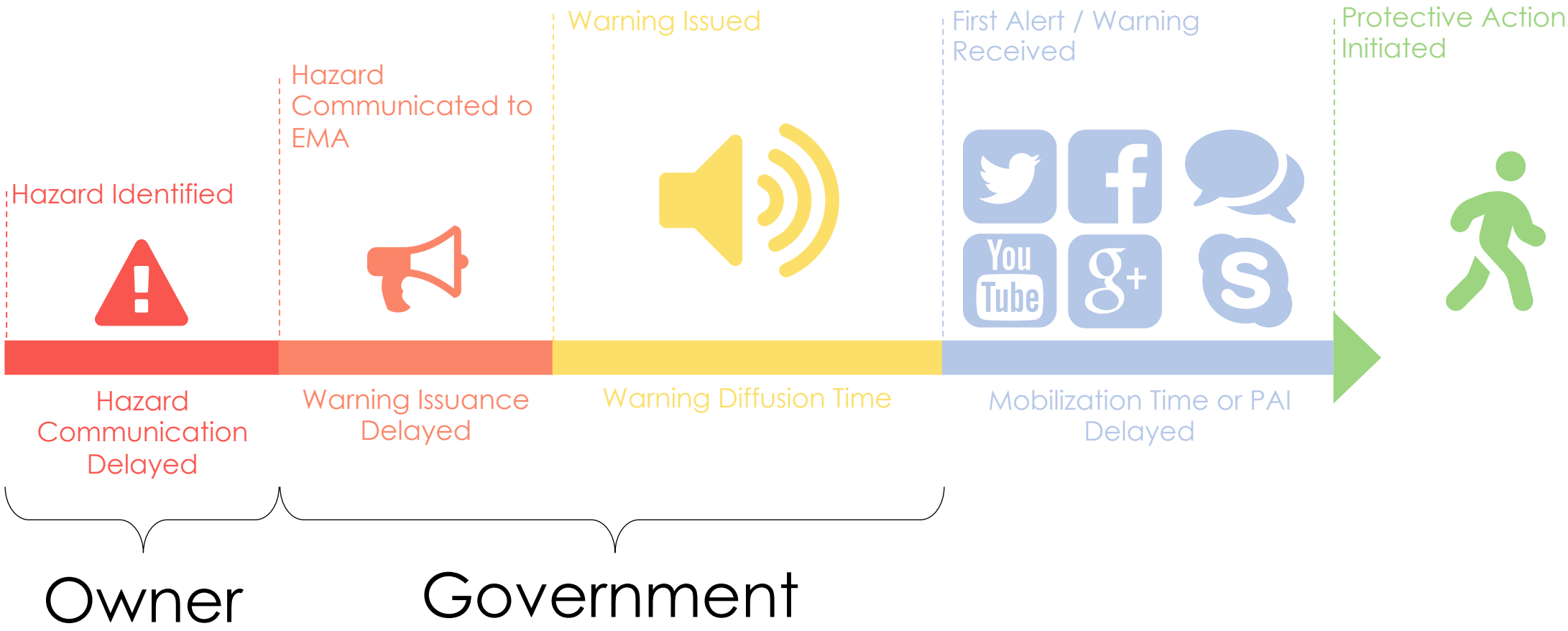
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Emergency Level of Thailand

Red		Extremely risk stage – Civilians have to stay in safe shelter or evacuate to nearest shelter and comply the command
Orange		High risk stage – Officials are controlling the situation, civilians have to evacuate to shelter and follow the prescribed guidelines
Yellow		Risk stage – situation pretend to more dangerous, civilians prepare for the situation and follow the guidance
Blue		Caution stage – Follow the news closely
Green		Normal stage – Follow the news regularly

Reference: National Disaster Warning Center (2015)

Warning Time



Source: USACE

Dam Break Analysis

Guidance for Estimating When Dam Failure Warnings Would be initiated (Earthfill Dam)

Dam Type	Cause of Failure	Special Considerations	Time to Failure	When Would Dam Failure Warning be Initiated?	
				Many Observers at Dam	No Observers at Dam
Earthfill	Overtopping	Drainage area at dam less than 260 km^2	Day	0.25 hrs before dam failure	0.25 hrs after floodwater reaches populated area
			Night	0.25 hrs after dam failure	1.0 hrs after floodwater reaches populated area
		Drainage area at dam more than 260 km^2	Day	2 hrs before dam failure	1 hr before dam failure
			Night	1 to 2 hrs before dam failure	0 to 1 hr before dam failure
	Piping (full reservoir, normal weather)		Day	1 hr before dam failure	0.25 hrs after floodwater reaches populated area
			Night	0.5 hrs after dam failure	1.0 hr after floodwater reaches populated area
	Seismic	Immediate Failure	Day	0.25 hrs after dam failure	0.25 hrs after floodwater reaches populated area
			Night	0.50 hrs after dam failure	1.0 hr after floodwater reaches populated area
		Delayed Failure	Day	2 hrs before dam failure	0.5 hrs before floodwater reaches populated area
			Night	2 hrs before dam failure	0.5 hrs before floodwater reaches populated area

Homeland Security, Estimating Loss of Life for Dam Failure Scenarios (2011)

Dam Break Analysis

Recommended Fatality Rates for Estimating Loss of Life Resulting from Dam Failure

Flood Severity	Warning Time (Minutes)	Flood Severity Understanding	Fatality Rate (Fraction of people at risk projected to die)	
			Suggested	Suggested Range
HIGH	No warning	Not Applicable	0.75	0.30 – 1.00
	15 to 60	Vague	Use the values shown above and apply to the number of people who remain in the dam failure floodplain after warning are issued. No guidance is provided on how many people will remain in the floodplain.	
		Precise		
	More than 60	Vague		
		Precise		
MEDIUM	No warning	Not Applicable	0.15	0.03 – 0.35
	15 to 60	Vague	0.04	0.01 – 0.08
		Precise	0.02	0.005 – 0.04
	More than 60	Vague	0.03	0.005 – 0.06
		Precise	0.01	0.002 – 0.02
LOW	No warning	Not Applicable	0.01	0.0 – 0.02
	15 to 60	Vague	0.007	0.0 – 0.015
		Precise	0.002	0.0 – 0.004
	More than 60	Vague	0.0003	0.0 – 0.0006
		Precise	0.0002	0.0 – 0.0004

Dam Break Analysis

Flood Severity	Warning Time (Minutes)	Flood Severity Understanding	Remain PAR after Received Warning Message (%)	Fatality Rate		
				Suggested	Suggested Range	For Analysis
H6	No warning	Not Applicable	100	0.75	0.30 – 1.00	0.75
	15 to 60	Vague	50	-		0.30
		Precise	25			0.30
	More than 60	Vague	10			0.30
		Precise	1			0.30
H5	No warning	Not Applicable	100	0.15	0.03 – 0.35	0.35
	15 to 60	Vague	50	0.04	0.01 – 0.08	0.04
		Precise	25	0.02	0.005 – 0.04	0.02
	More than 60	Vague	10	0.03	0.005 – 0.06	0.005
		Precise	1	0.01	0.002 – 0.02	0.002
H4	No warning	Not Applicable	100	0.15	0.03 – 0.35	0.35
	15 to 60	Vague	50	0.04	0.01 – 0.08	0.04
		Precise	25	0.02	0.005 – 0.04	0.02
	More than 60	Vague	10	0.03	0.005 – 0.06	0.005
		Precise	1	0.01	0.002 – 0.02	0.002
H3	No warning	Not Applicable	100	0.01	0.0 – 0.02	0.02
	15 to 60	Vague	50	0.007	0.0 – 0.015	0.007
		Precise	25	0.002	0.0 – 0.004	0.002
	More than 60	Vague	10	0.0003	0.0 – 0.0006	0
		Precise	1	0.0002	0.0 – 0.0004	0
H2	No warning	Not Applicable	100	0.01	0.0 – 0.02	0.02
	15 to 60	Vague	50	0.007	0.0 – 0.015	0.015
		Precise	25	0.002	0.0 – 0.004	0.002
	More than 60	Vague	10	0.0003	0.0 – 0.0006	0
		Precise	1	0.0002	0.0 – 0.0004	0
H1	No warning	Not Applicable	100	0.01	0.0 – 0.02	0.0
	15 to 60	Vague	50	0.007	0.0 – 0.015	0.0
		Precise	25	0.002	0.0 – 0.004	0.0
	More than 60	Vague	10	0.0003	0.0 – 0.0006	0.0
		Precise	1	0.0002	0.0 – 0.0004	0.0

Dam Break Analysis

$$PAR = \left(\frac{Population}{Urban\ Area}\right) \times Floodplain\ Area$$

where

PAR = Population at Risk (People)

Population = Number of the population living in the village (People)

Urban Area = Area of the living zone in the village (m2)

Floodplain Area = Area of floodplain in the Urban Area (m2)

$$LoL = PAR \times Fatality\ Rate$$

where

LoL = Loss of Life (Person)

Population = Number of the population living in the village

Fatality Rate = The ratio of deaths from flood event



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