Disaster Risks in Ayeyarwady Delta, Irrigation and Flood Protection.

CLIMATIC CONDITION

Seasons

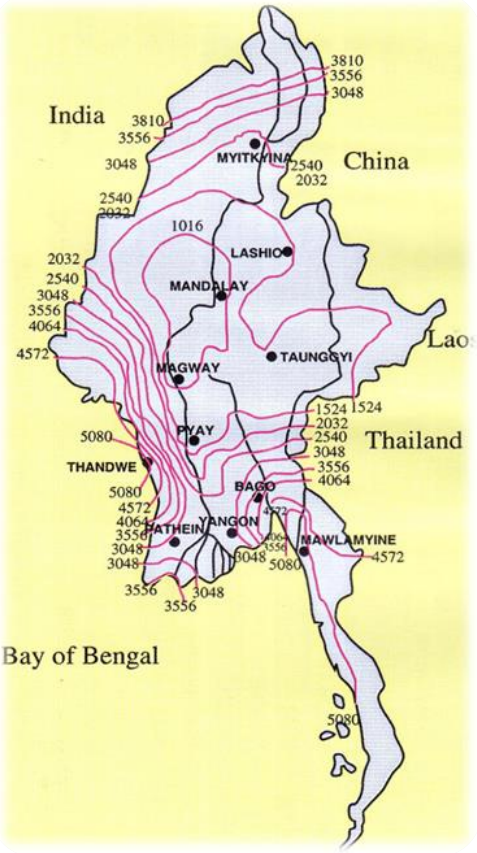
- *Summer* March to mid-May
- *Monsoon* mid-May to end of October
- *Cold* November to end of February

Temperature

- Changing 34 to 43 °C during summer and
  10 to 16 °C during winter in the different localities

Precipitation

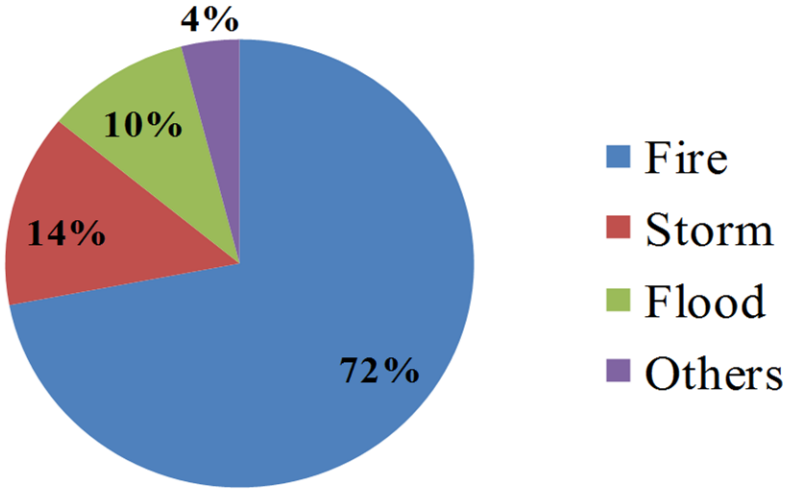
- northern part 2000 - 3800 mm
- middle dry zone less than 760 mm
- delta regions 2030 - 3050 mm
- coastal areas more than 5000 mm

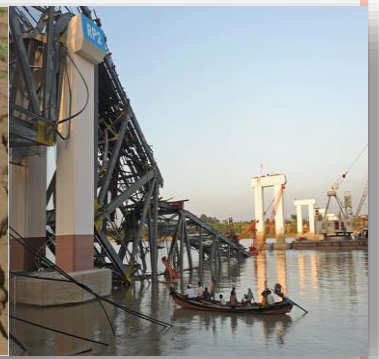


several natural hazards

cyclones, earthquakes, floods, fires, tsunamis and landslides, hit periodically .

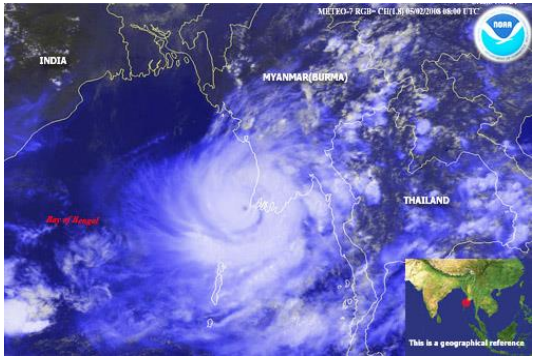
floods in the Ayeyarwady Region is 16% of the disasters.

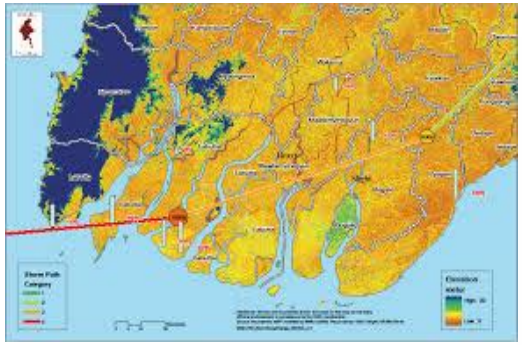




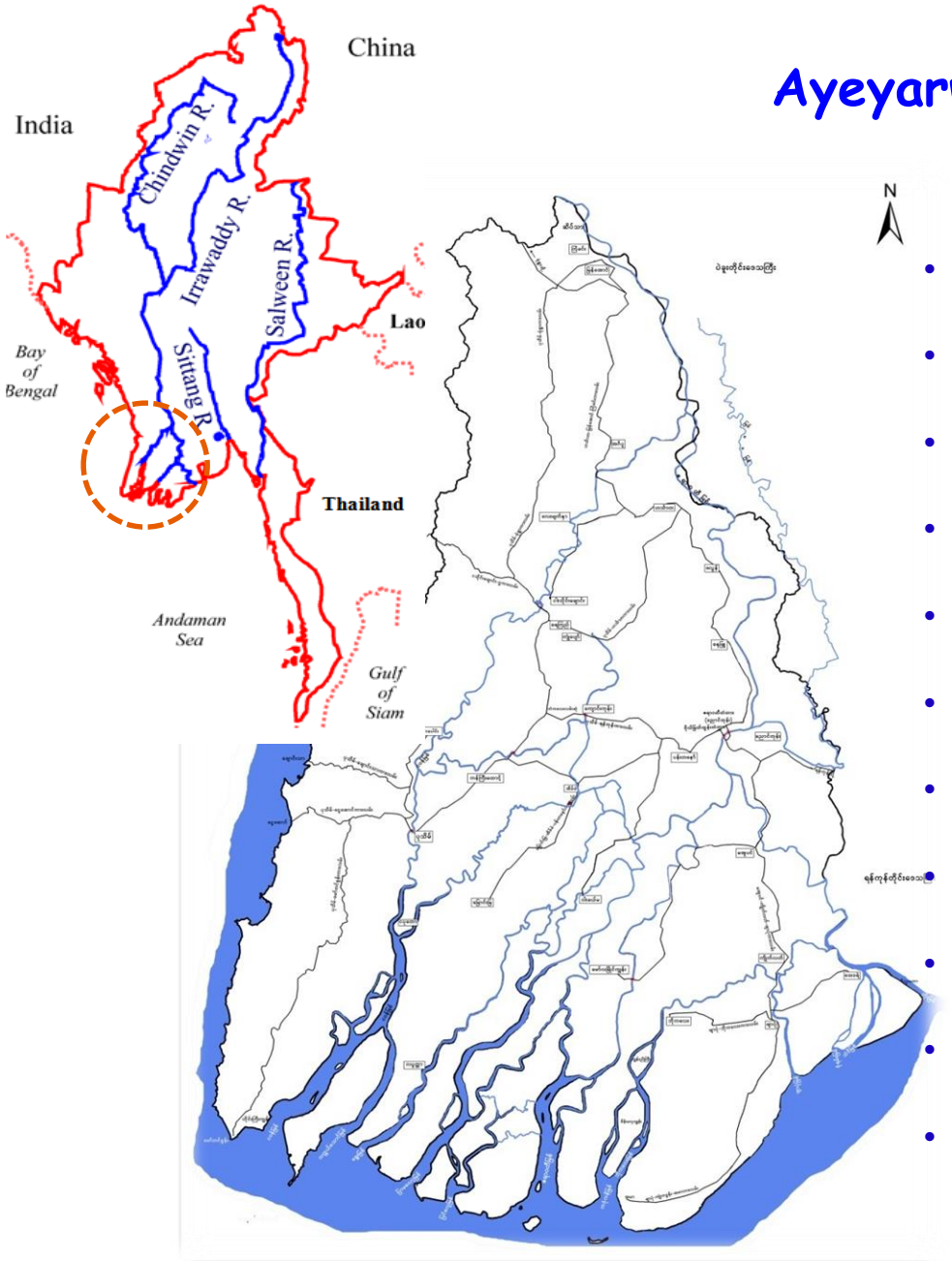
Recent major disasters

- ❖ Earthquake in Taungdwingyi (M: 6.8 RS) , 2003 , loss of live = 7
- ❖ Indian Ocean Tsunami, 2004, loss of live = 61
- ❖Cyclone Mala, 2006, loss of live = 37
- ❖Cyclone Nargis, 2008, loss of live and missing = 138373
- ❖ Earthquake in Bagan, (M: 6.8 RS), 24.8.2016, loss of live = 4, 397 temples damaged.



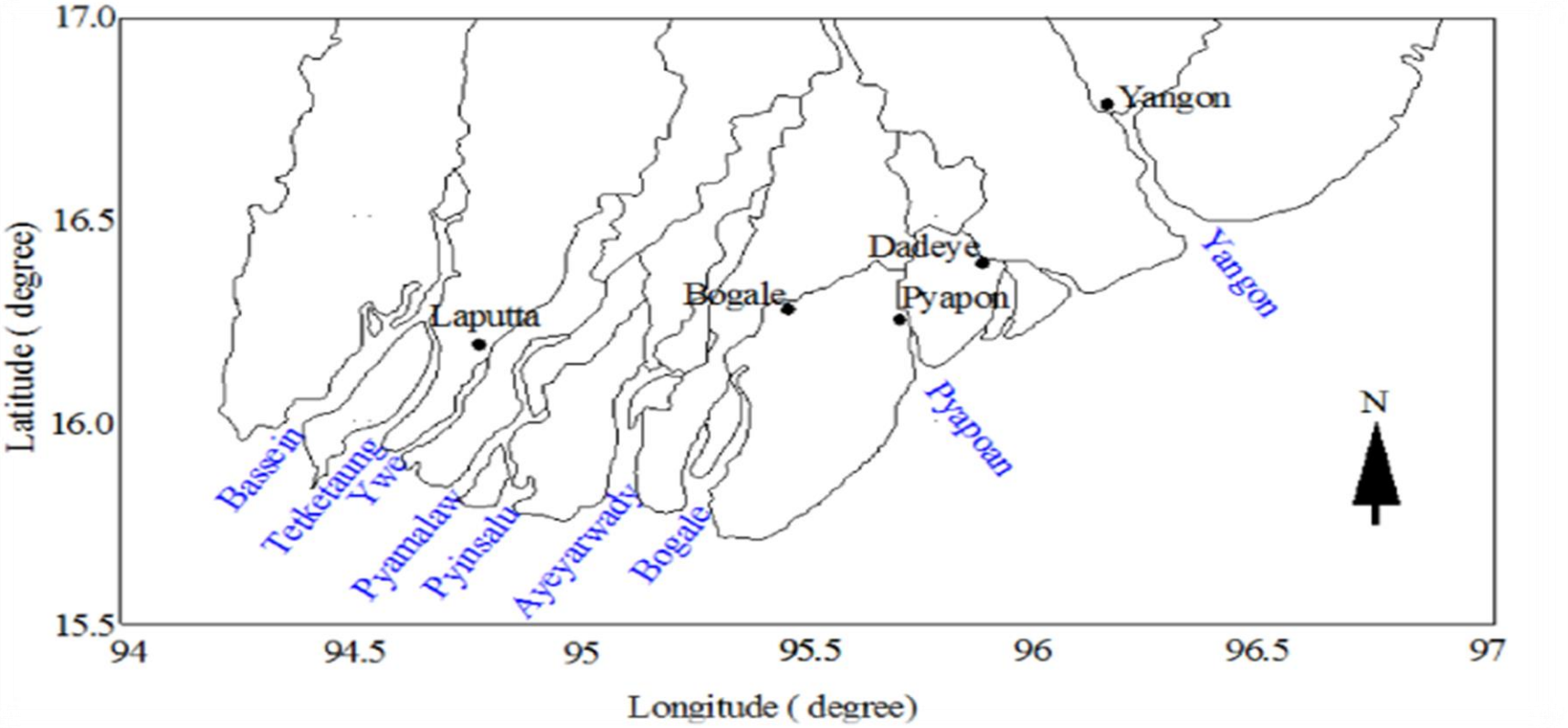


Ayeyarwady Delta (Region) Over view



- a shape of a triangle, flared to the sea.
- North to south - 288km
- East to west - 240km
- a stretch of flat plain
- over 35000 sqkm , 3m above MSL
- ≈ 320 sqkm , lower than spring tide
- Land slope - 0.00005
- Max discharge at apex -32600m^3/sec
- Sediment transport -180 mil ton/year
- Progress rate of Delta -49m/year
- population - 6.18 mil

Estuaries



- Fresh and saltwater,- depose sediment with nutrients, transformed into fertile & fragile delta
- Salinity- influencing growth and distribution of plants
- Mangroves - characteristic forest type, buffer to storm surge, provide ideal nursery grounds for fish and wildlife species.
- supports over 6 million people and produces ≈ 60% of country's rice production Private prawn farms and deforestation - destroyed the delta environment.

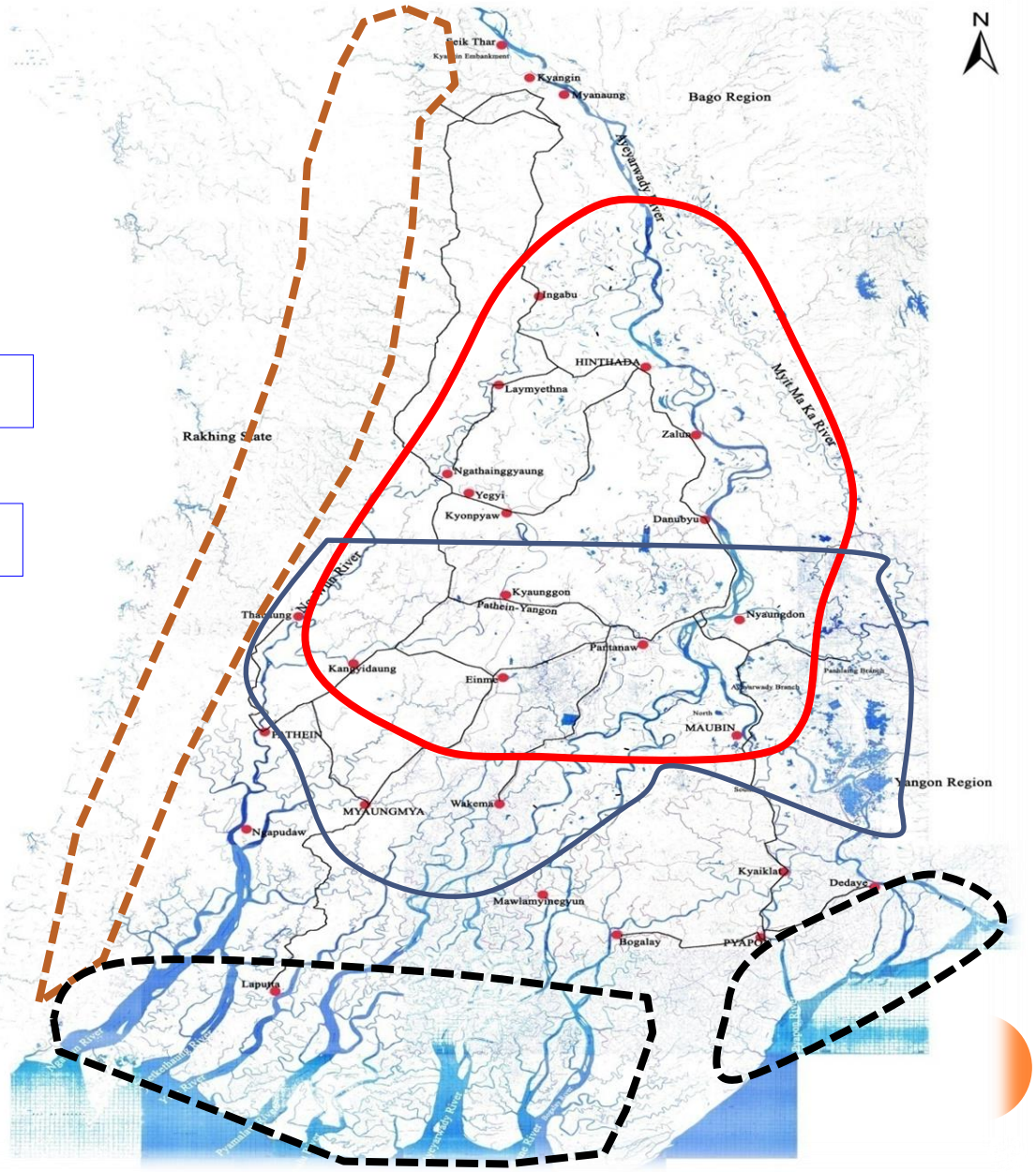
Vulnerable Area

Mountain Ranges

Riverine flood Zone

Localized flood prone area

Estuarine and coastal area



Sedimentation

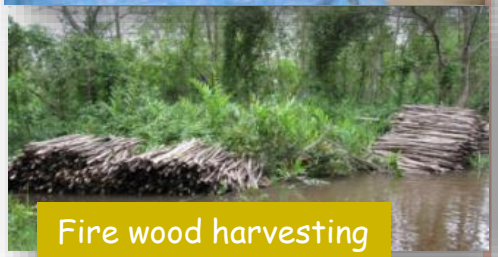
- Rivers are active with bank erosion, emergence of sand bars progressively high
- increase suspended load (Deforestation , Gold/ mineral/ Gem and precious stone extractions, Dam and storage reservoir construction)
- Bridge construction and other development activities obstruct the river flow, that process instigate the sediment deposition in the lower delta.
- Changes of river flow pattern by the climate change impact comes high sedimentation and make worse the river deterioration .

River Bank and Coastal Erosion

- One of the major issues, many places along the upper delta.
- River geo-morphology is very dynamic
- Mangrove destruction (shrimp ponds, reclamation for cultivations, migrant of fishermen communities, firewood collection and charcoal production)


Shrimp pond establishment

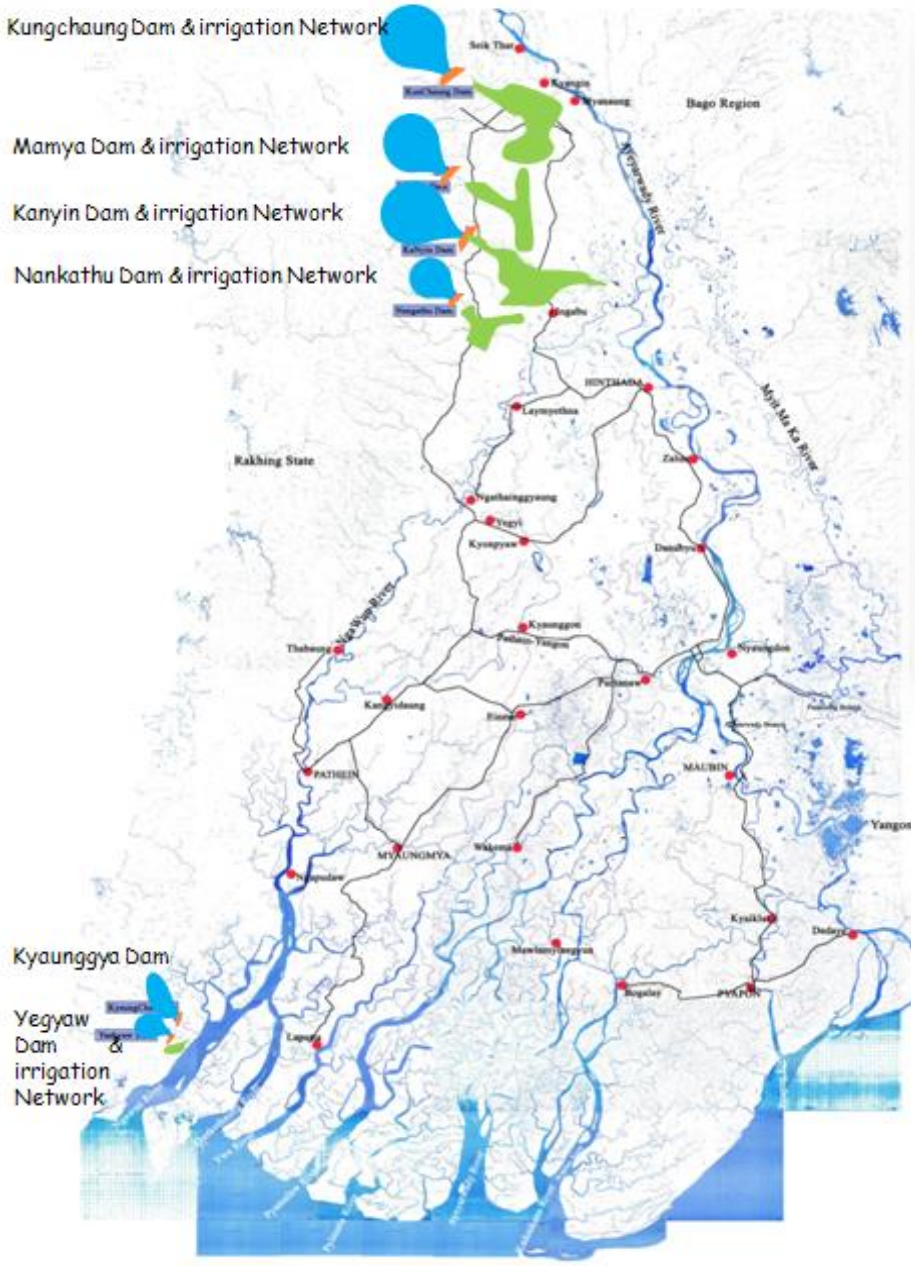

Charcoal kilning


Fire wood harvesting


Reclaim for cultivation


New settlements

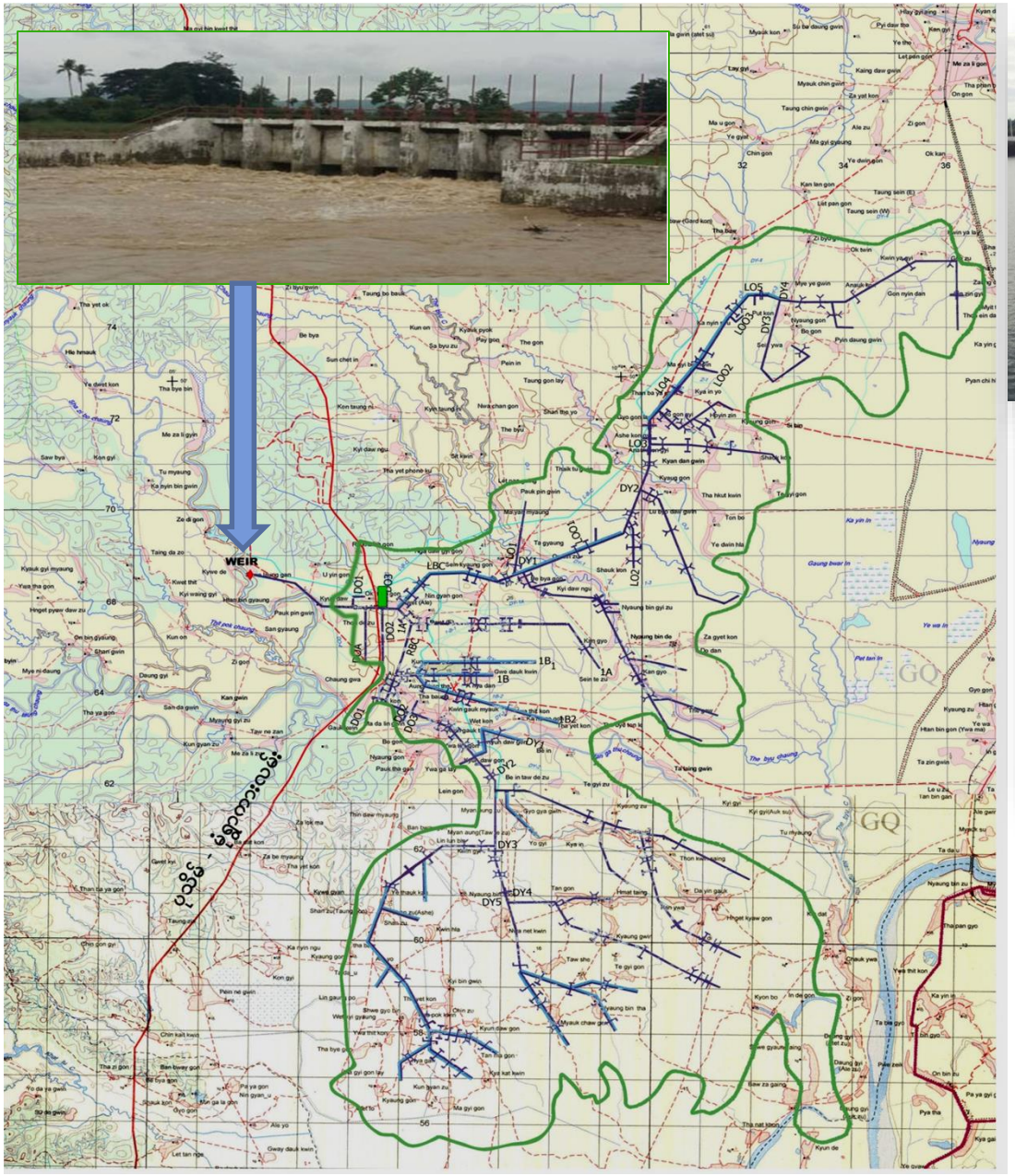
Location of Storage Reservoirs in Ayeyarwady Region



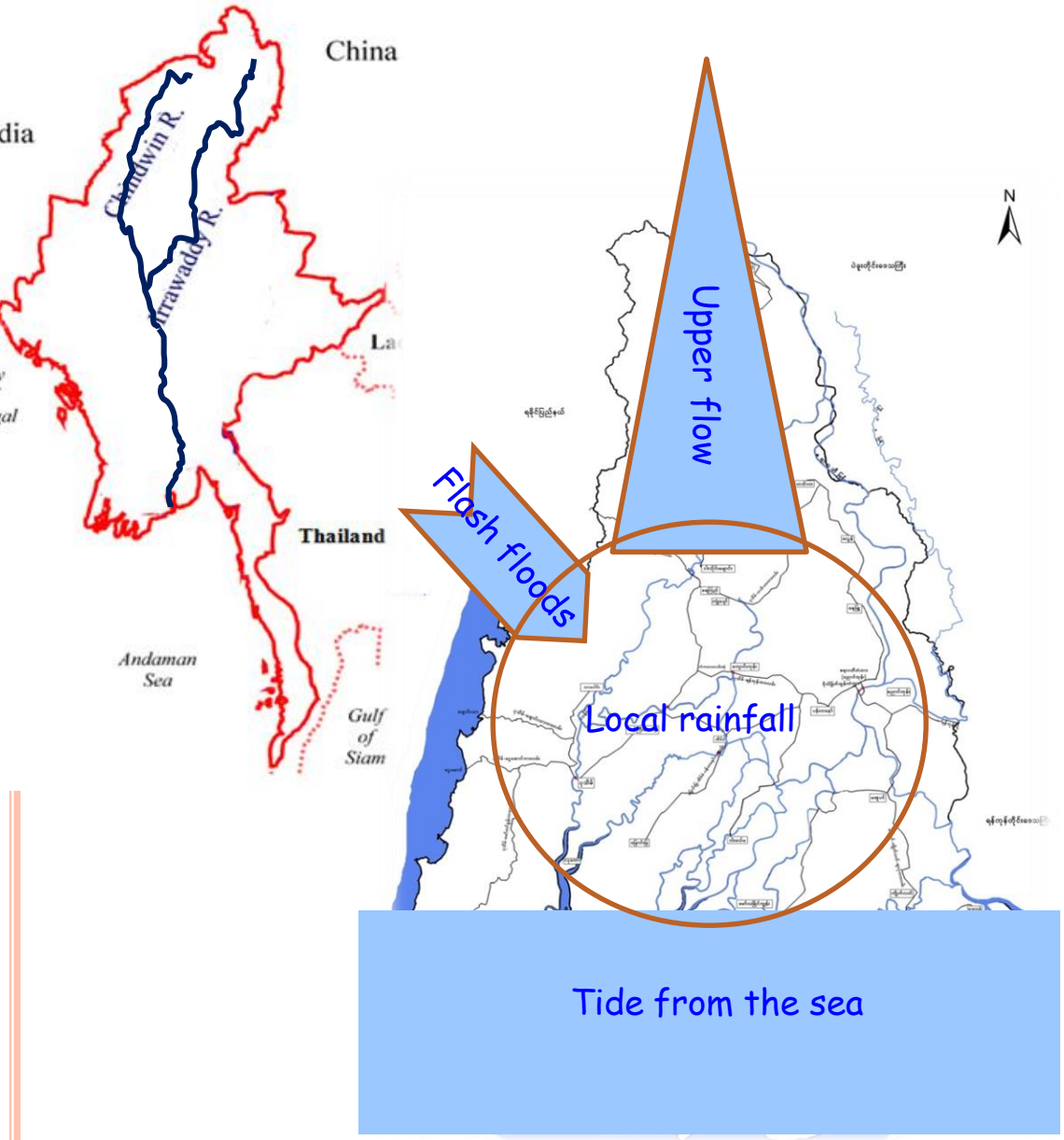
Reservoir	Storage capacity (A-ft)	Irrigable area (Acre)	Domestic supply(mil gl)	Power generation (MW)
Kunchaung	98400	10000	-	-
Mamya	70000	8300	-	0.5
Kanyin	145000	155000	-	5.0
Nankathu	40000	5200	-	0.6
Kyaunggya	240	-	65	-
Yegyaw	1200	-	324	-

Kunchaung Irrigation Networ

Nankathu Irrigation Network



Floods and inundation



Causes of flooding in the AYD delta

- The coincidence of high flows in the upper rivers cause to be big floods in Ayd delta.
- Flash floods come from the western ranges.
- The effect of tides instigate the river flood high..
- The heavy intensive rain cause trouble upon trouble.

Historical Information of Dikes in Myanmar

River dikes were constructed along the Ayeyarwady river, Sittaung river and Ngawun river since 19th century.

The major river dikes, western Ayeyarwady Embankments, eastern Ayeyarwady Embankments, Ngawun Embankments, Sittaung Embankments and Bago Embankments, and these were constructed between 1860s and 1880s.

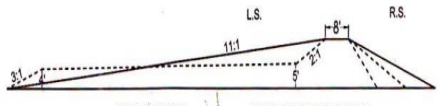
The British engineers designed , constructed the urban dikes along the Ayeyarwady and Ngawun river, during colonial era.

Urban dikes were also constructed continuously in town area along the Ayeyarwady and Ngawun river.

Dikes were reconstructed and improved from time to time as the river regime is changing yearly.

Cross Section of the Embankments

- All the dikes in Myanmar are earthen dikes without facing any materials.
- Nowaday, key trench is provided in dike construction .

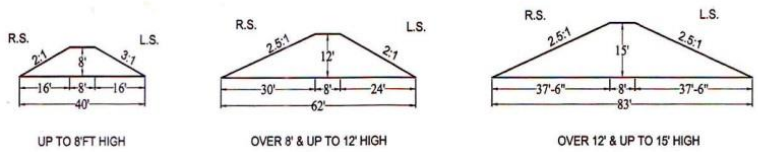


SAND SECTIONS SLOPE ACCORDING TO HIGH

FOR SAND IN EMBANKMENT USE 11:1 BACK SLOPE

FOR SAND IN FOUNDATION, MIXED EARTH IN EMBANKMENT, USE BANQUETTE SECTION

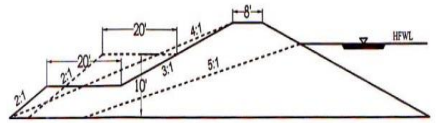
Standard Sections of the Dike with various height of the Dike



UP TO 8'FT HIGH

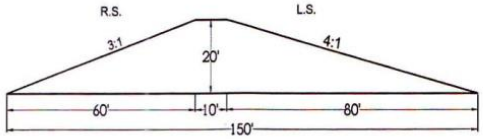
OVER 8' & UP TO 12' HIGH

OVER 12' & UP TO 15' HIGH

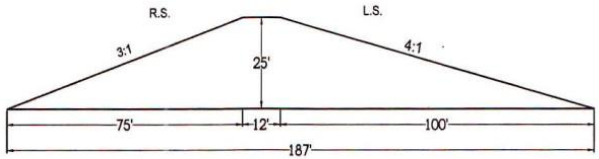


SECTION SUITABLE WHERE SLIPS OCCUR 3:1 RIVER SIDE SLOPE

3:1 LAND SIDE SLOPE WITH 20FT. BANQUETTE 5FT.
HIGH MINIMUM COVER OVER 5:1 H.G. 2 FT

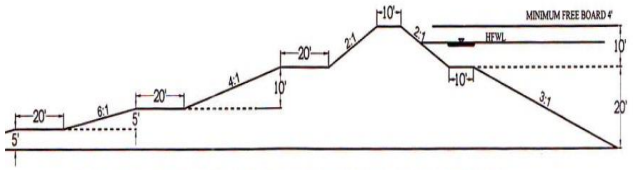


OVER 15' & UP TO 20' HIGH



OVER 20' & UP TO 25' HIGH

ALTERNATIVES 4:1 LAND SIDE SLOPE OR 10 FT BANQUETTE 20 FT WIDE



SECTION SUITABLE FOR SOFT FOUNDATION S HIGH EMBANKMENT

Dikes under the care of Irrigation Department

Sr. no.	State/Region	Flood Protection			Sea water Protection			Total			Remark
		no.	Length (mile)	Protected Area (acre)	no.	Length (mile)	Protected Area (acre)	no.	Length (mile)	Protected Area (acre)	
1	Kayin	2	1.360	2372	-	-	-	2	1.360	2372	
2	Sagaing	6	49.090	42146	-	-	-	6	49.090	42146	
3	Tanintharyi	-	-	-	14	54.320	10754	14	54.320	10754	
4	Bago	39	387.400	515907	-	-	-	39	387.400	515907	
5	Magway	1	1.500	1160	-	-	-	1	1.500	1160	
6	Mandalay	2	10.989	5649	-	-	-	2	10.989	5649	
7	Naypyidaw	5	17.040	16956	-	-	-	5	17.040	16956	
8	Mon	-	-	-	18	50.190	20536	18	50.190	20536	
9	Rakhine	-	-	-	32	207.890	79584	32	207.890	79584	
10	Yangon	19	101.280	78481	22	234.050	203489	41	335.330	281970	
11	Shan	1	41.000	-	-	-	-	1	41.000	-	
12	Ayeyarwady	29	733.535	1356101	35	583.400	339177	64	1316.935	1695278	
		104	**1343.194**	**2018772**	**121**	**1129.850**	**653540**	**225**	**2473.044**	**2672312**	

Total length of dikes - 3975 km

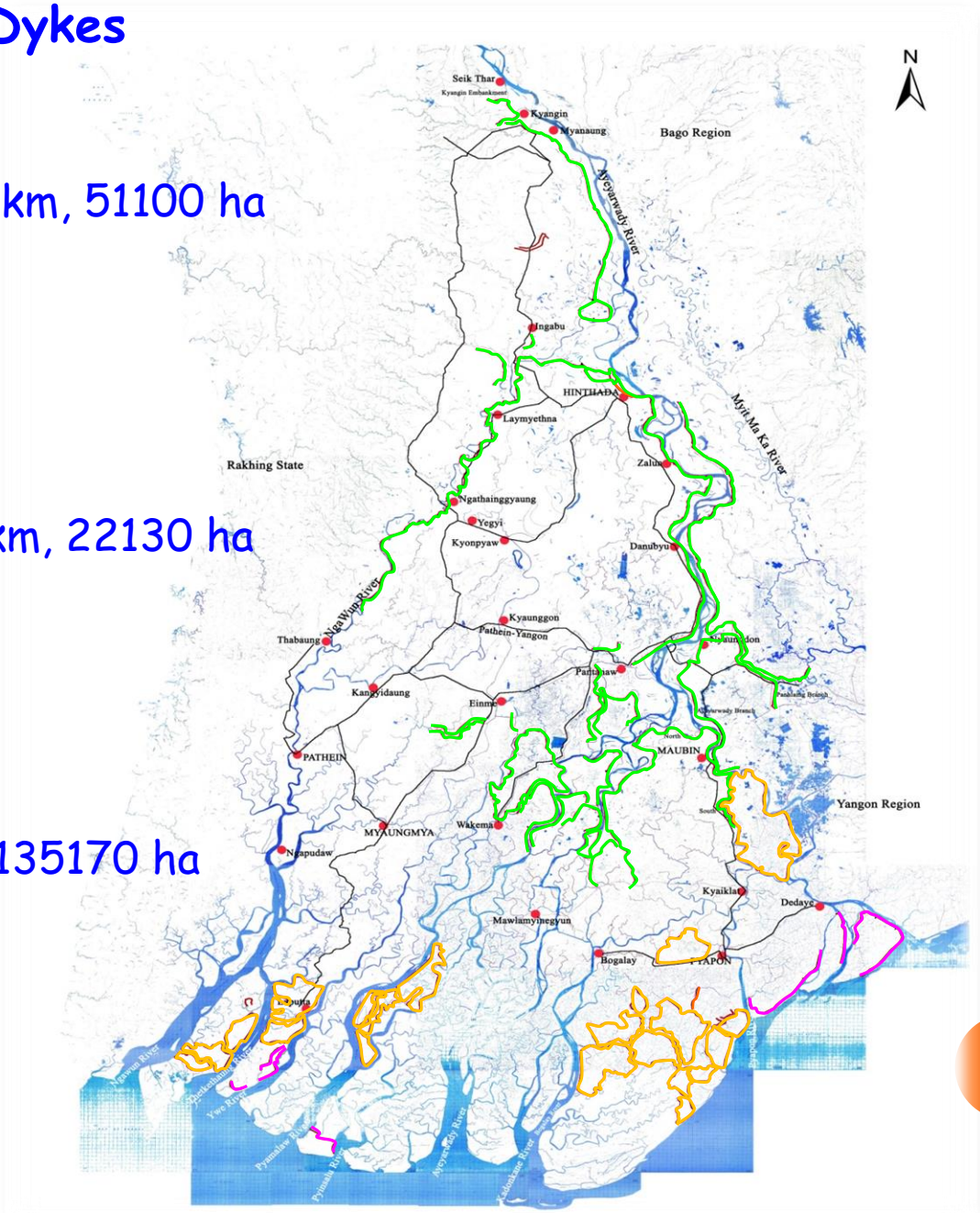
Total Protected area - 1077545 ha

Flood Protection Dykes

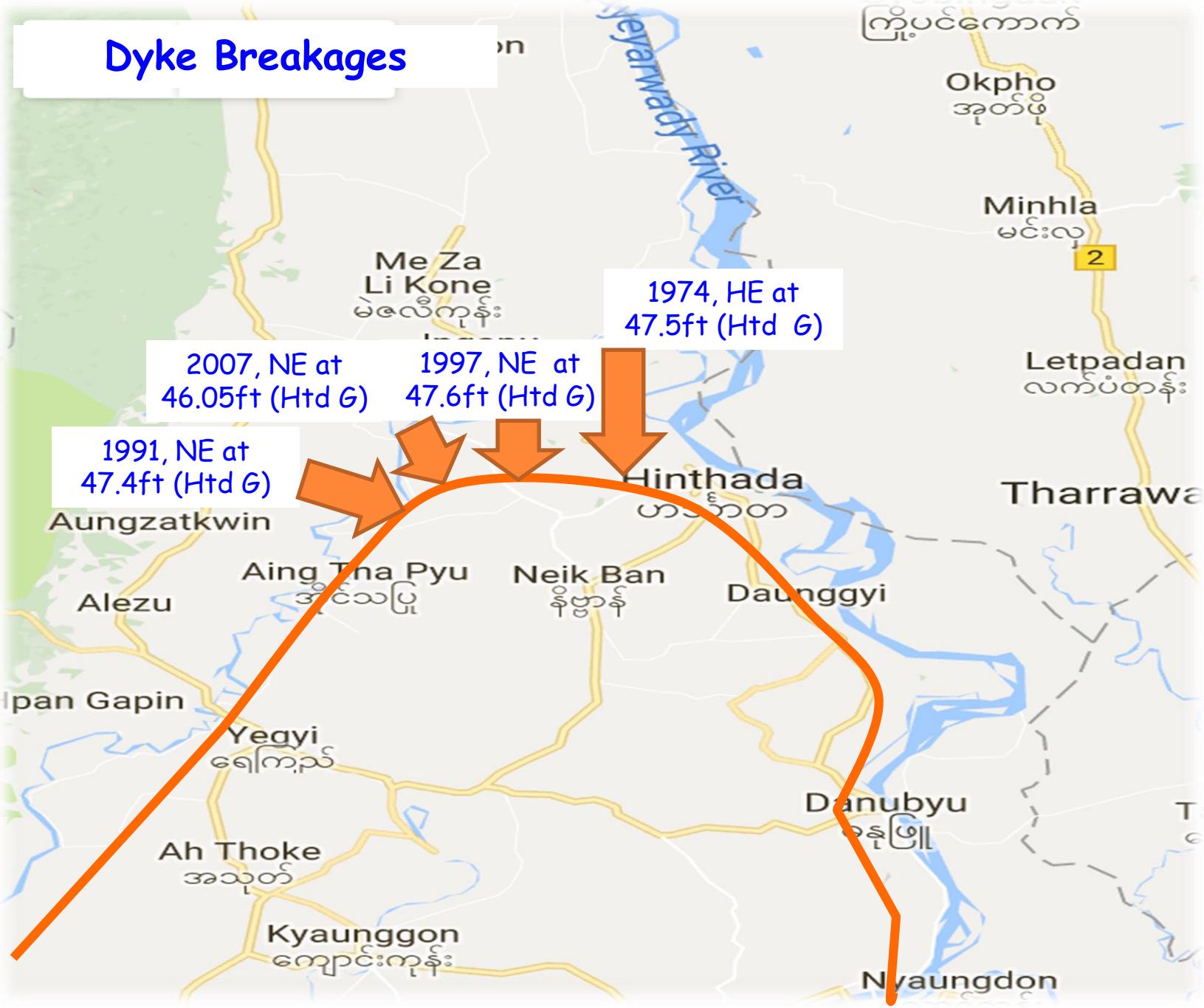
Riverine dykes 1011 km, 51100 ha

seawater Protection dykes 112km, 22130 ha

polders 974km, 135170 ha



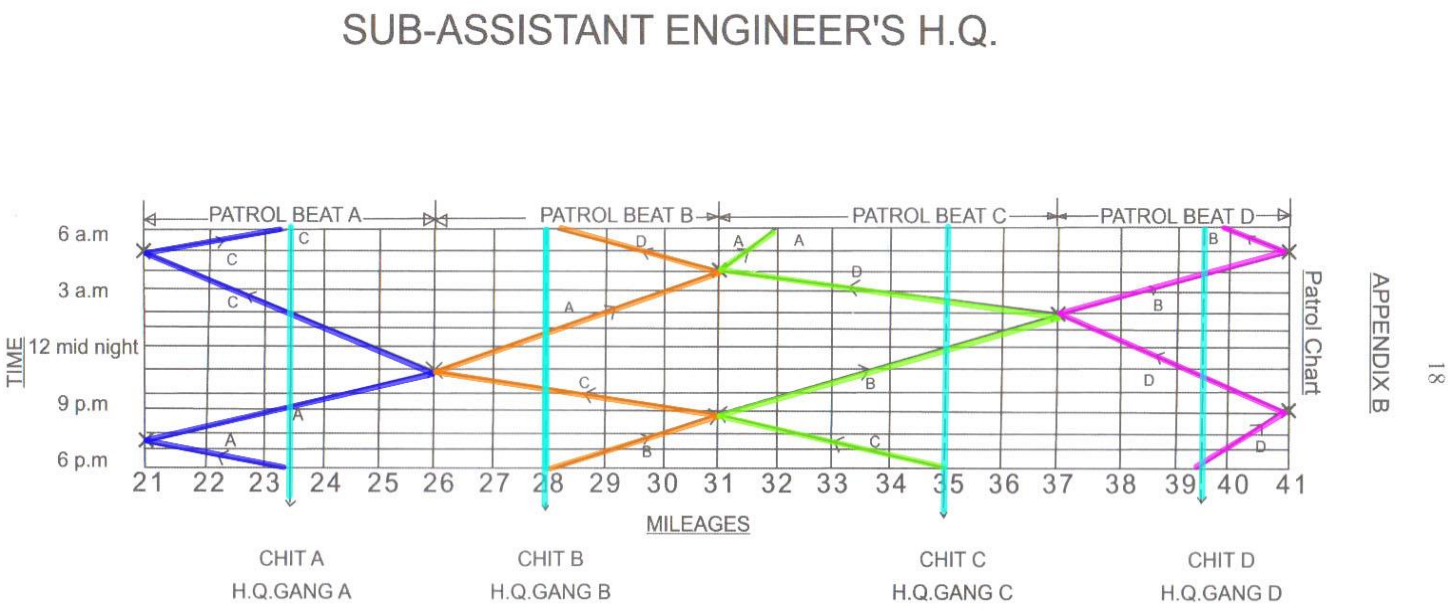
Dyke Breakages



Maintenance and Care of Dykes

- Regular inspection along the dikes conducted by embankment officer
- Clearing bushes and shrubs growing on the slope of the dike and the toe
- Treatment of Leak holes due to rodents, termites, insect and some reptiles etc…
- Investigation of LS & CS of dyke, bank offset measurements
- Ordinary maintenance and Special repairs of dykes, new dyke(retirement) established where necessary.
- emergency materials are collected at the patrol camps located every 4 miles each.
- providing wireless network or mobile phone communication system
- On foot patrol in the respective jurisdiction before 1 foot to meet danger water level.

Patrol chart for care of dykes in flood period



Patrol Chart

APPENDIX B

18

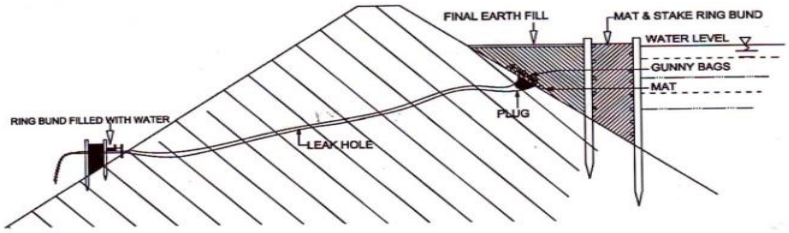
Points marked X are where Chits are changed, or are signed by a Responsible person at the end of a Beat.

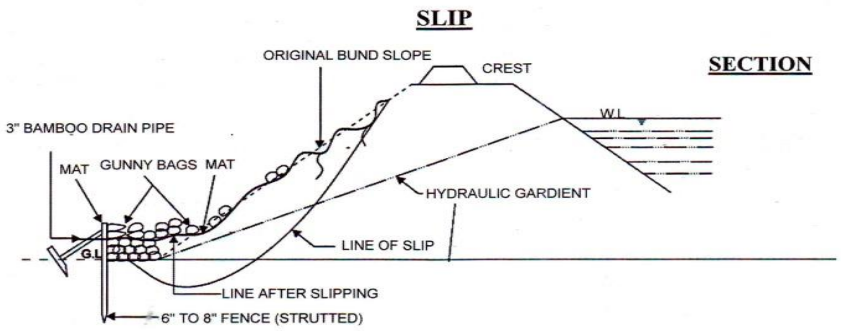
A etc. show how Chits move and where they end.

Causes of Failure and Methods of Emergency Tackling

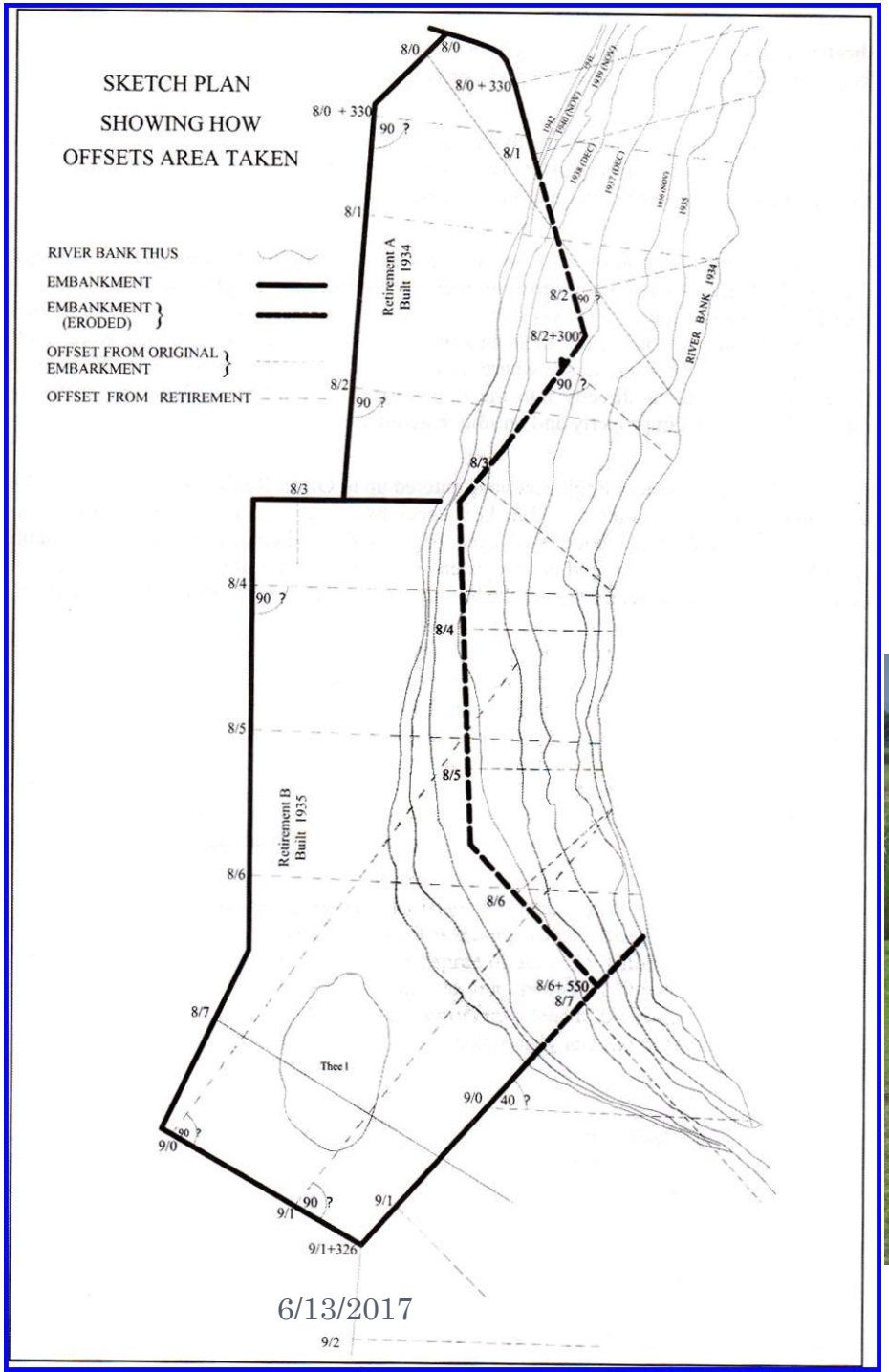
- Over topping due to subsidence of crest
- Side slope slip due to inadequate section & poor quality of fill materials
- Leakage due to rodents, termites, insect and some reptiles etc…
- Crack due to surface temperature and unequal settlements as well
- Bank erosion due to the river currents
- Weak foundation of dykes and
- Wave washing

for leakage control



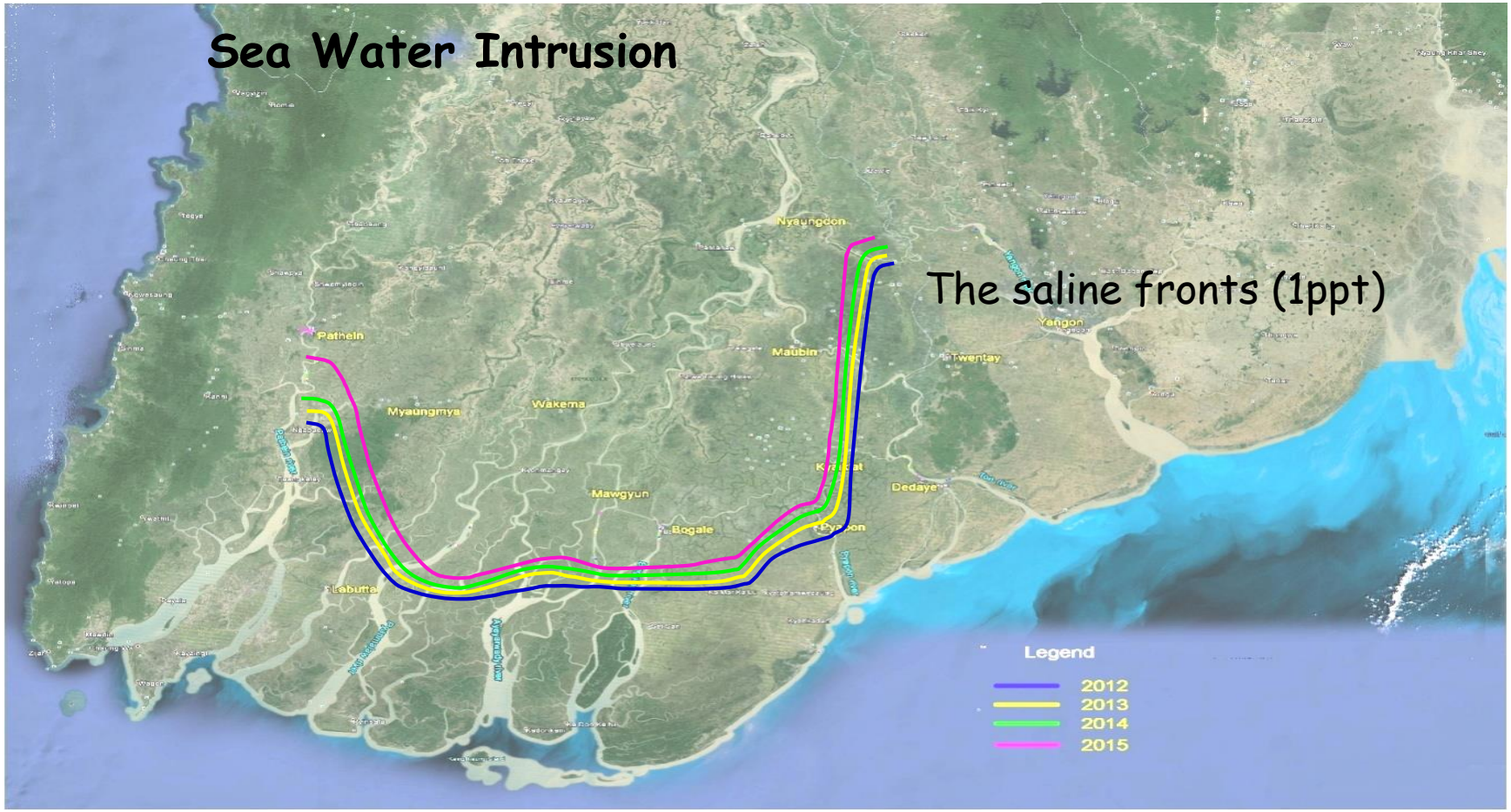


for slip control


SKETCH PLAN
SHOWING HOW
OFFSETS AREA TAKEN
RIVER BANK THUS
EMBANKMENT
EMBANKMENT (ERODED)
OFFSET FROM ORIGINAL EMBARKMENT
OFFSET FROM RETIREMENT
Retirement A Built 1934
Retirement B Built 1935
RIVER BANK 1934
8/0
8/0 + 330
8/1
8/2
8/2+300
8/3
8/4
8/5
8/6
8/6+ 550
8/7
9/0
9/1
9/1+326
9/2
90 ?
40 ?
Thee l

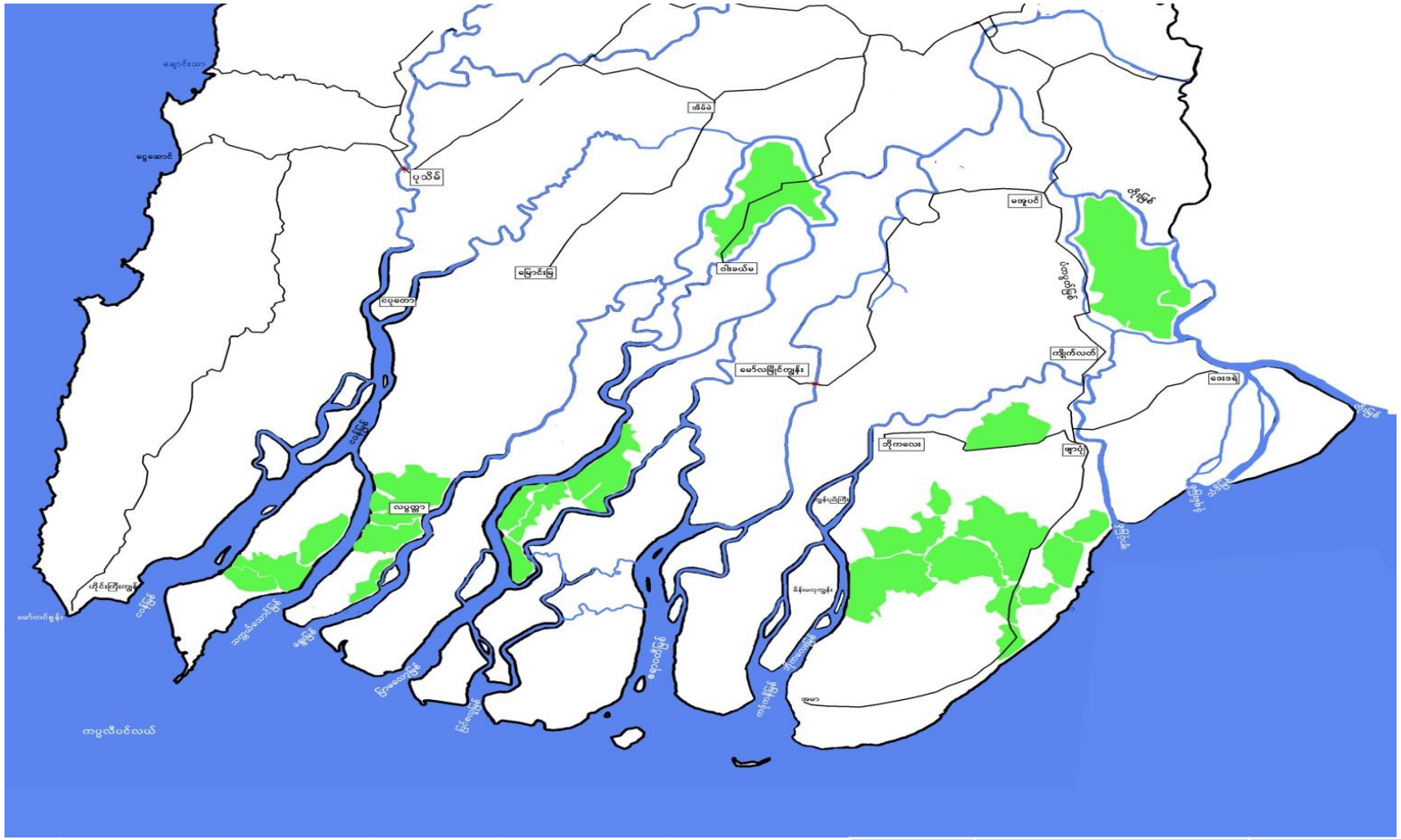
River Trained in upper AYD

Sea Water Intrusion



- The exacerbated issue Progressive moving up stream
- U/S flow diminishing and Sea-level rising
- Make worse saline front progressing and more saltine intrusion
- varies seasonally, depending on river runoff, local rainfall and the strength of ocean currents.
- water from tube and open well could not potable
- Drinking water scarcity, a challenge in the late dry season
- The rain water is harvested traditionally by communal ponds

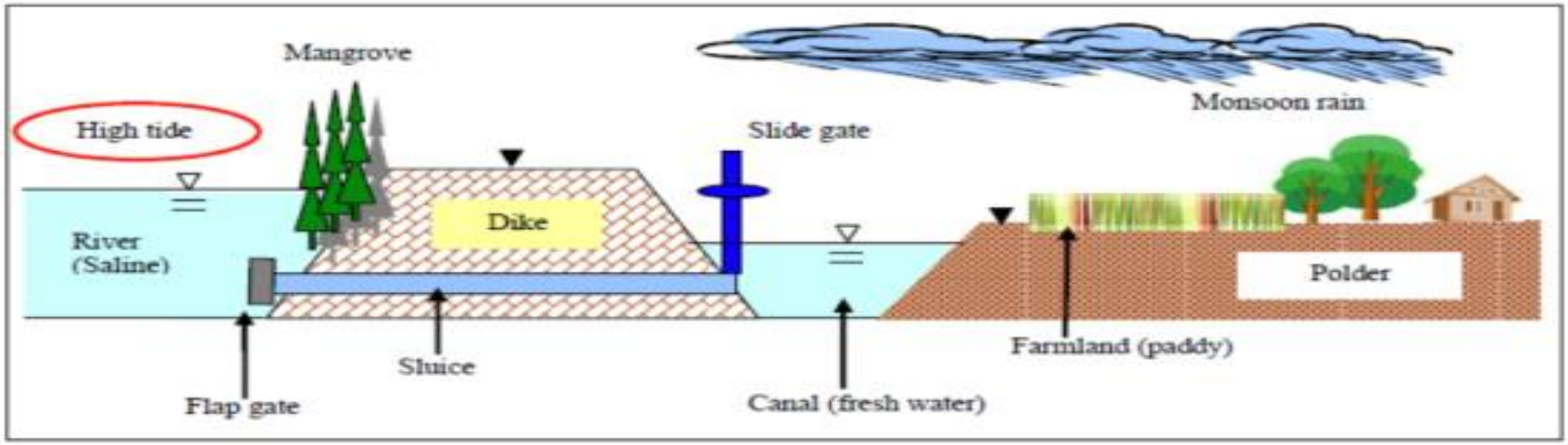
Polders in Ayd delta

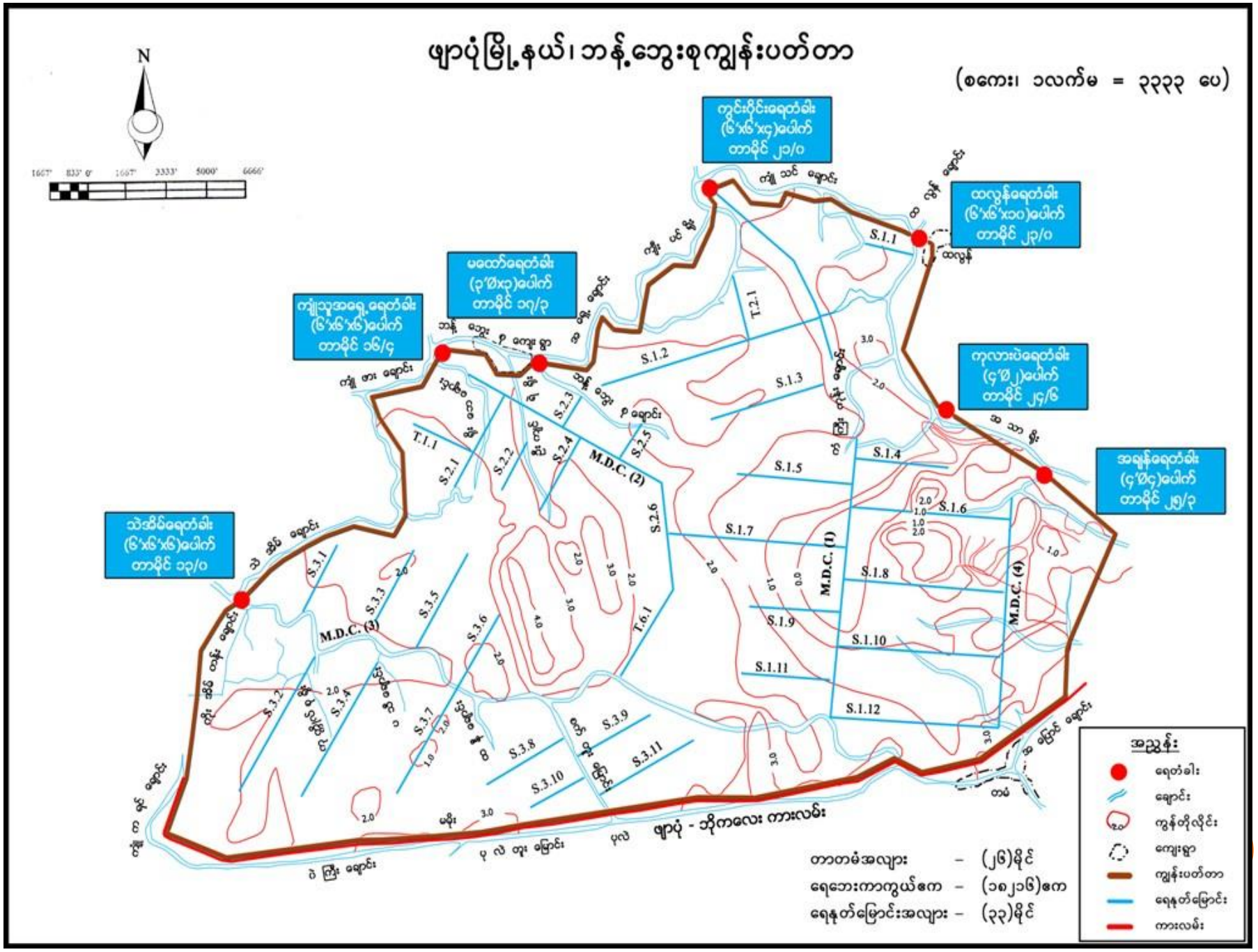


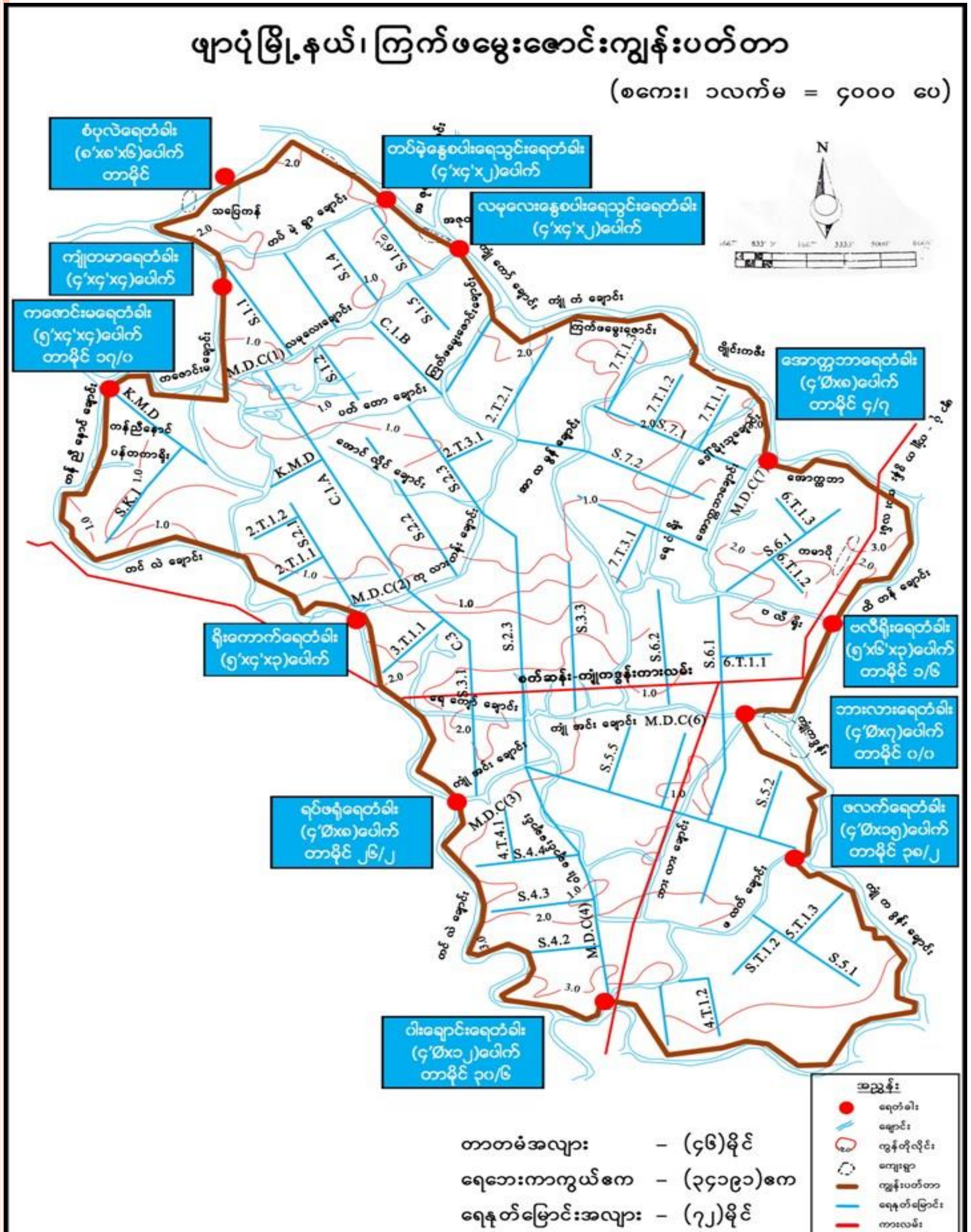
Phase	polders (No)	Length (Km)	Sluice (No)	Drainage (km)	Beneficial area (ha)	Phase	Commencement	Completion
I	11	643.2	65	664	82983	I	August, 1976	June, 1985
II	4	393.6	84	430.4	76497	II	July, 1978	April, 1990

Functioning of a polder in the lower delta

- ❖supplementary irrigation is not needed during the monsoon season.
- ❖no need to store abundant rainwater during the rainy season.
- ❖ due to the heavy rainfall intensities, the role of the drainage canal is very important.
- ❖The slide gates of the sluice are kept open in rainy season and the drainage is controlled by the flap gates of the sluice to keep the water level of the drainage canals as low as possible.
- ❖The old river courses are functioning as major drainage channels, small artificial drainage canals are connected as required in the areas surrounded by polder dikes, artificial drainage canals are predominant.




ဗျာပုံမြို့နယ်၊ ဘန့်ဘွေးစုကျွန်းပတ်တာ
(စကေး၊ ၁လက်မ = ၃၃၃၃ ပေ)
N
1667' 833' 0' 1667' 3333' 5000' 6666'
ကွင်းဝိုင်းရေတံခါး
(၆'၀၆'x၄)ပေါက်
တာမိုင် ၂၁/၀
ထလွန်ရေတံခါး
(၆'၀၆'x၁၀)ပေါက်
တာမိုင် ၂၃/၀
မထော်ရေတံခါး
(၃'၀x၃)ပေါက်
တာမိုင် ၁၇/၃
ကျူးသူအရွှေ့ရေတံခါး
(၆'x၆'x၆)ပေါက်
တာမိုင် ၁၆/၄
ကုလားပဲရေတံခါး
(၄'၀_၂)ပေါက်
တာမိုင် ၂၄/၆
အရွှန်ရေတံခါး
(၄'၀၄)ပေါက်
တာမိုင် ၂၅/၃
သဲအိမ်ရေတံခါး
(၆'x၆'x၆)ပေါက်
တာမိုင် ၁၃/၀
S.1.1
S.1.2
S.1.3
S.1.4
S.1.5
S.1.6
S.1.7
S.1.8
S.1.9
S.1.10
S.1.11
S.1.12
S.2.1
S.2.2
S.2.3
S.2.4
S.2.5
S.2.6
S.3.1
S.3.2
S.3.3
S.3.4
S.3.5
S.3.6
S.3.7
S.3.8
S.3.9
S.3.10
S.3.11
T.1.1
T.2.1
T.6.1
M.D.C. (1)
M.D.C. (2)
M.D.C. (3)
M.D.C. (4)
ဗျာပုံ - ဘိုကလေး ကားလမ်း
တာတမံအလျား – (၂၆)မိုင်
ရေဘေးကာကွယ်စကေ – (၁၈၂၁၆)စကေ
ရေနုတ်မြောင်းအလျား – (၃၃)မိုင်
အညွှန်း
ရေတံခါး
ချောင်း
ကွန်တိုလိုင်း
ကျေးရွာ
ကျွန်းပတ်တာ
ရေနုတ်မြောင်း
ကားလမ်း


ဖျာပုံမြို့နယ်၊ ကြက်ဖမွေးဆောင်းကျွန်းပတ်တာ
(စကေး၊ ၁လက်မ = ၄၀၀၀ ပေ)
N
တာတမံအလျား – (၄၆)မိုင်
ရေဘေးကာကွယ်ဧက – (၃၄၁၉၁)ဧက
ရေနုတ်မြောင်းအလျား – (၇၂)မိုင်

Present Issues

- Sea level rise
- Intensive Rainfall in the polders
- Deposition of sediment in out-fall channels in dry season (≈ 1 m)
- Widespread inundation in the polder (rainy season)
- Restriction of budget allotments
- Suitable machine deficiencies
- Level of acidity in the soil comes high
- Natural channels or creeks need to be dredged up
- Polder facilities such as dyke, sluices and drainage canals also need to be rehabilitated.

Challenges in dyke maintenance

- Possibility of overtopping dyke increases due to heavy deposition of sediment in the river as a result of deforestation and up stream deteriorations.
- Continuous and gradual rising of river bed level that would need for raising of dikes
- Limited funding for strengthening, rehabilitation and maintenance of dykes
- Likelihood of occurrence of more severe floods and cyclone due to climate change, that necessitates both raising and strengthening dykes
- Lack of utilization of modern technology to cover all the dikes in investigation and pinpointing the weak sections of the dykes
- Lack of technical knowhow and equipments for application of geophysical method for investigation of dykes
- Shortage of qualified staff in using geophysical instruments and interpretation of measured data


Thank you very much
for your attention