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
Ayeyarwady Delta (Region) Overview

- 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 -32600 m³/sec
- Sediment transport - 180 mil ton/year
- Progress rate of Delta - 49m/year
- population - 6.18 mil
Fresh and saltwater - deposite 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)
Location of Storage Reservoirs in Ayeyarwady Region

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Storage capacity (A ft)</th>
<th>Irrigable area (Acre)</th>
<th>Domestic supply (mil gal)</th>
<th>Power generation (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kunchaung</td>
<td>98400</td>
<td>10000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mamyen</td>
<td>70000</td>
<td>8300</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Kanyin</td>
<td>145000</td>
<td>155000</td>
<td>-</td>
<td>5.0</td>
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<tr>
<td>Nankathu</td>
<td>40000</td>
<td>5200</td>
<td>-</td>
<td>0.6</td>
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<tr>
<td>Kyaunggya</td>
<td>240</td>
<td>-</td>
<td>65</td>
<td>-</td>
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<tr>
<td>Yegyaw</td>
<td>1200</td>
<td>-</td>
<td>324</td>
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</tr>
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</table>
Kunchaung Irrigation Network
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.
- Nowadays, key trench is provided in dike construction.

Standard Sections of the Dike with various height of the Dike
# Dikes under the care of Irrigation Department

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>State/Region</th>
<th>Flood Protection</th>
<th>Sea water Protection</th>
<th>Total</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>no.</td>
<td>Length (mile)</td>
<td>Protected Area (acre)</td>
<td>no.</td>
</tr>
<tr>
<td>1</td>
<td>Kayin</td>
<td>2</td>
<td>1.360</td>
<td>2372</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Sagaing</td>
<td>6</td>
<td>49.090</td>
<td>42146</td>
<td>-</td>
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<tr>
<td>3</td>
<td>Tanintharyi</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Bago</td>
<td>39</td>
<td>387.400</td>
<td>515907</td>
<td>-</td>
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<tr>
<td>5</td>
<td>Magway</td>
<td>1</td>
<td>1.500</td>
<td>1160</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Mandalay</td>
<td>2</td>
<td>10.989</td>
<td>5649</td>
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<tr>
<td>7</td>
<td>Naypyidaw</td>
<td>5</td>
<td>17.040</td>
<td>16956</td>
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<td>8</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>18</td>
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<tr>
<td>9</td>
<td>Rakhine</td>
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<td>-</td>
<td>-</td>
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<td>733.535</td>
<td>1356101</td>
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</tbody>
</table>

|              | 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

1974, HE at 47.5ft (Htd G)

1991, NE at 47.4ft (Htd G)

1997, NE at 47.6ft (Htd G)

2007, NE at 46.05ft (Htd G)

1974, HE at 47.5ft (Htd G)
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

SUB-ASSISTANT ENGINEER'S H.Q.

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 1 (ERODED)
OFFSET FROM ORIGINAL 1
EMBARKMENT
OFFSET FROM RETIREMENT

6/13/2017
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 be potable
- Drinking water scarcity, a challenge in the late dry season
- The rain water is harvested traditionally by communal ponds
### Polders in Ayd delta

<table>
<thead>
<tr>
<th>Phase</th>
<th>Polders (No)</th>
<th>Length (Km)</th>
<th>Sluice (No)</th>
<th>Drainage (km)</th>
<th>Beneficial area (ha)</th>
<th>Phase</th>
<th>Commencement</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11</td>
<td>643.2</td>
<td>65</td>
<td>664</td>
<td>82983</td>
<td>I</td>
<td>August, 1976</td>
<td>June, 1985</td>
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<tr>
<td>II</td>
<td>4</td>
<td>393.6</td>
<td>84</td>
<td>430.4</td>
<td>76497</td>
<td>II</td>
<td>July, 1978</td>
<td>April, 1990</td>
</tr>
</tbody>
</table>
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.
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 upstream 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