WORLD WATER WEEK
in Stockholm, August 26–31, 2012

Presentation from the

2012 World Water Week in Stockholm

www.worldwaterweek.org

www.siwi.org SIWI

World Water Week
Stockholm
August 26-31, 2012

Best Use of Blue Water Resources for Food Security

RICE BOWL OF MYANMAR : THE AYEYARWADDY DELTA AND IT'S WATER MANAGEMENT DEVELOPMENTS THROUGH THE AGES OF PADDY PRODUCTION

Presented by
Aye Myint
Senior Water Resources Engineer
National Engineering and Planning Services Co.Ltd.
Myanmar
(uamyint@gmail.com)

WORLD WATER WEEK in Stockholm, August 26–31, 2012

EPS National Engineering & Planning Services

Rice Bowl of Myanmar : The Ayeyarwaddy Delta and It's Water Management Developments Through the Ages of Paddy Production

OUTLINES

- Introduction
- Food Security
  - Comparison between World and Myanmar
  - Myanmar Population vs. Paddy Production
  - 3 Rice Bowls of Asia
- Ayeyarwaddy Delta of Myanmar
- Developments Schemes of Ayeyarwaddy Delta
- Future Blue Water Resources Development Potential
- Future population Trend vs. Expected Paddy Production in Myanmar
- Impact of Climate Change in Ayeyarwaddy Delta
- Conclusion and Recommendation

MYANMAR

Location: South East Asia Peninsula
Between 10ºN to 28ºN (latitude)
92.5ºE to101.5ºE (longitude)

Border: Bangladesh, India, China, Laos, Thailand, Bay of Bengal, Andaman Sea

Land Area: 676,553 sq km

Topography: Flat land, river valleys, hills, plateau and mountains

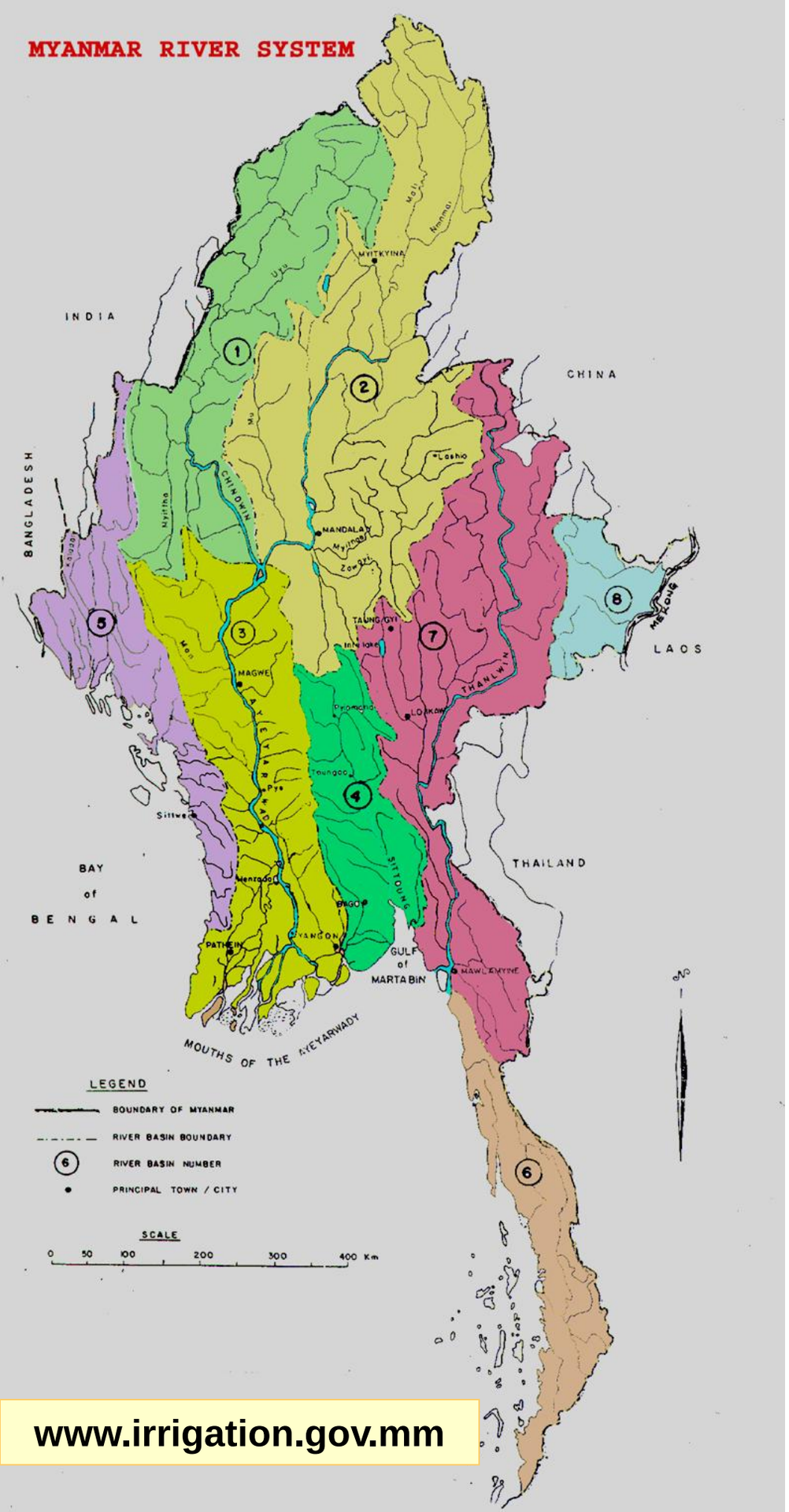
Climate: Tropical

Rainfall: Less than 900 mm in Central Myanmar

Temperature: Above 40°C during hot season in Central Myanmar

Population: 57.5 million (2009), over 70% is in rural area

Myanmar Water Partnership
MmWP



www.irrigation.gov.mm

Water Resources Potential of Myanmar

Major River System

1. Ayeyarwaddy River
2. Chindwin River
3. Sittaung River
4. Thanlwin River

River Basin No.	Name of the River Basin	Drainage Area (10^3 km^2)	Avg. Annual Surface Water (km^3)	Ground Water (km^3)
I	Chindwin	115.30	141.293	57.578
II	Upper Ayeyarwady	193.30	227.920	92.599
III	Lower Ayeyarwady	95.60	85.800	153.249
IV	Sittoung	48.10	81.148	28.402
V	Rakhine State	58.30	139.245	41.774
VI	Taninthari Division	40.60	130.927	39.278
VII	Thanlwin	158.00	257.918	74.779
VIII	Mekong	28.60	17.634	7.054
	Total	737.80	1081.885	494.713

Myanmar-Dutch Seminar on

"Water Sector Capacity Building and Possible Collaboration"

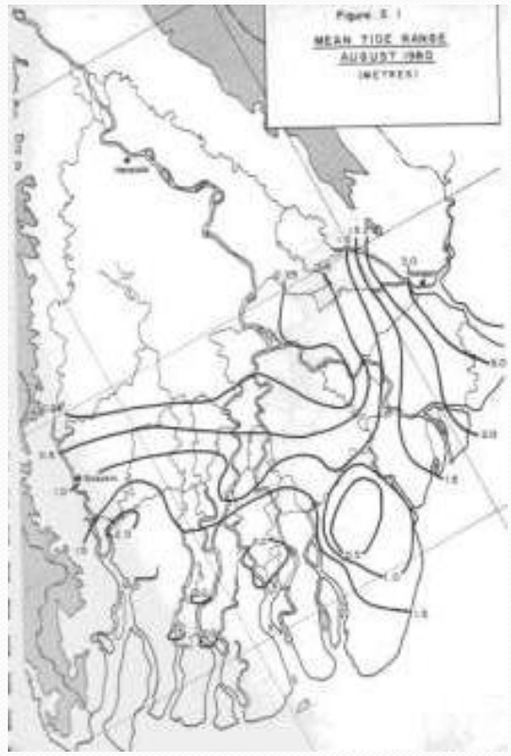
6th July 2012, Irrigation Dept. (Head Office), Yangon, Myanmar

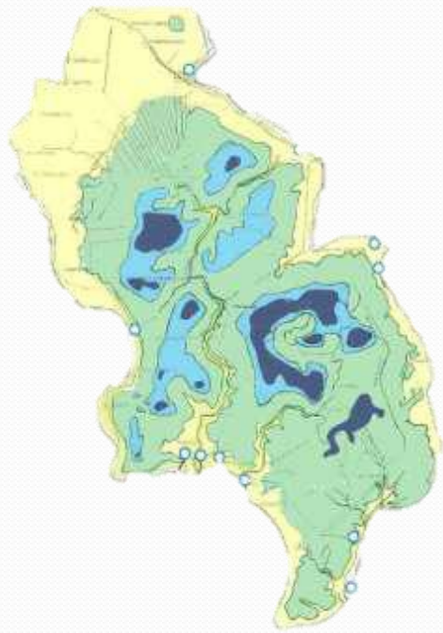
Myanmar Water Partnership
MmWP

Rice Bowl of Myanmar : The Ayeyarwaddy Delta and It's Water Management Developments Through the Ages of Paddy Production

Introduction

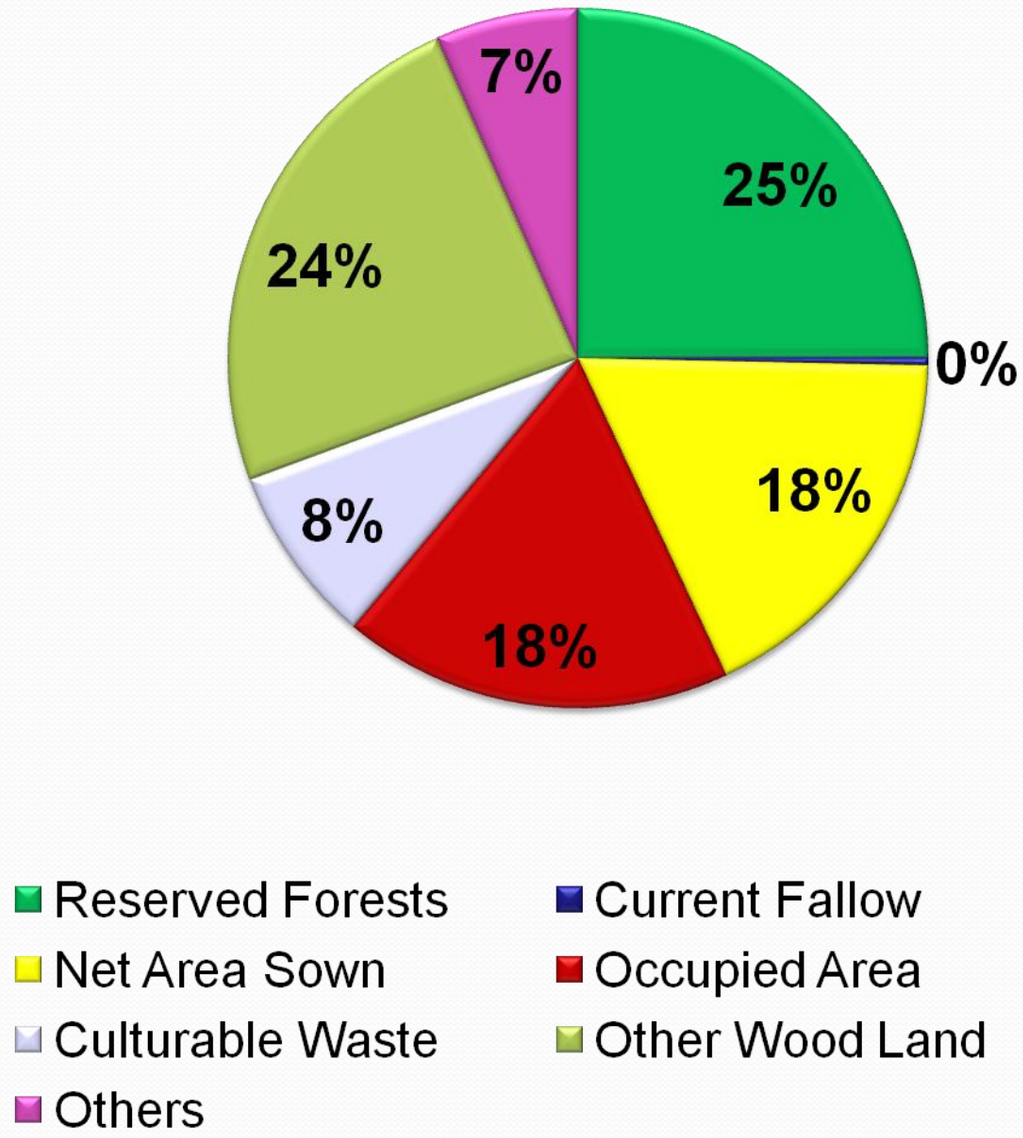
- Best Use of Blue Water Resources
  - For Food Security of Myanmar and Asian Countries
- Ayeyarwaddy Delta
  - Location
    - Strategic Place to Increase Paddy Production
  - Purpose
    - For Food Security of the Country's Growing Population
      - and Future Mega City, Yangon (adjacent to the delta)
    - For Regions beyond Myanmar's Borders
  - Unique Characteristics
    - Gravity Tidal Irrigation for Crops can be applied without using power
    - In some areas, fishing industry is integrated with paddy production
      - commonly found in reclaimed area
  - Issues
    - It is necessary to find the optimum solution
      - To benefit for all the water users for paddy and fish
      - To take into account the future climate change impact





Land Use of Myanmar in 2009-2010

Type of Land	1000 Acres	
Reserved Forests	*41752*	*25%*
Current Fallow	*597*	*0%*
Net Area Sown	*29591*	*18%*
Occupied Area	*30188*	*18%*
Culturable Waste	*13861*	*8%*
Other Wood Land	*40166*	*24%*
Others	*11031*	*7%*
Total Area	*167186*	*100%*



(Source:Statistical Year Book, 2010)

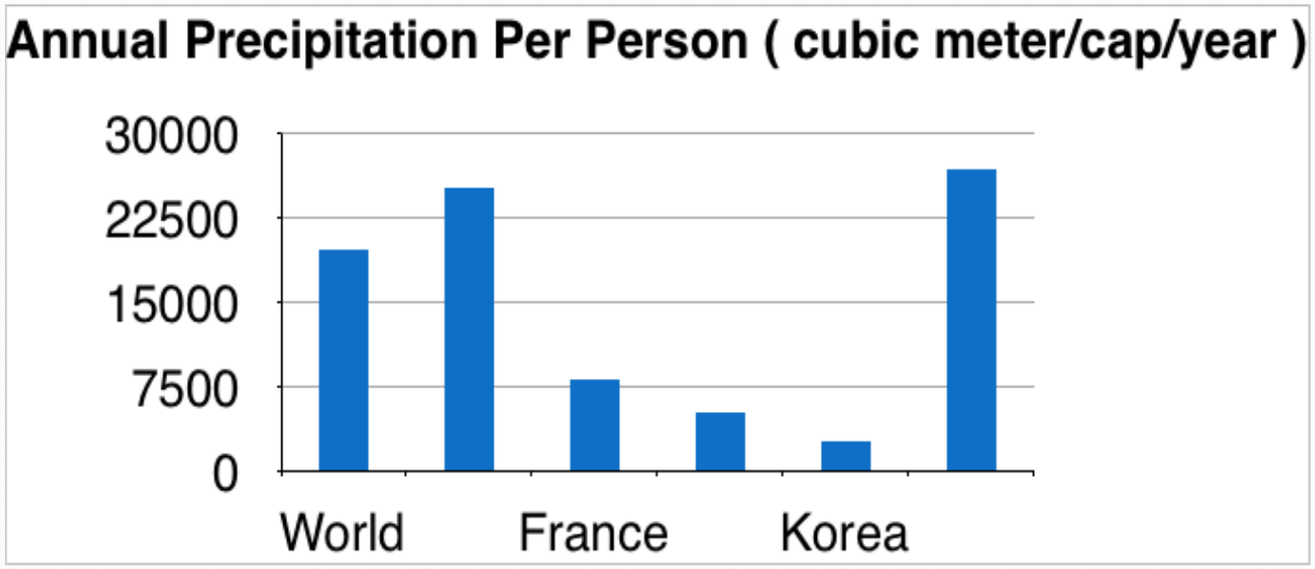
Water Resources Potential of Myanmar

- **Major River Basins of Myanmar**
  - 6 Numbers
- **Total Catchment Areas**
  - 737.8 x 1,000 Square Miles
- **Average Annual Rainfall**
  - 656 mm to 5742 mm
- **Population in 2009-10**
  - 59.13 millions [3]
- **Annual availability of water per Person of Myanmar**
  - 26,663 cubic meter/person/year
  - (2663 cubic meter/capita/year was found for Myanmar based on 59 million population and water resources potential of Myanmar on surface and ground water)

Water Resource Potential	Cubic Kilometers
Average Annual Surface Water	***1081.89***
Estimated Ground Water Potential	494.71
Total Water Resources Potential of Myanmar	***1576.60***

Water Resources Potential (Myanmar Vs. World)

Country	Annual Precipitation Per Person (Cu.m/cap/yr)
World	***19635***
USA	***25022***
France	***8069***
Japan	***5107***
Korea	***2591***
Myanmar	***26663***



Sources:
1.the Four Major River Restoration Project,August2010,Office of National River Restoration,
Ministry of Land ,Transport and Maritime Affairs, Republic of Korea, Presentation from the 2011World Water Week in Stockholm.
2.Aye Myint,IWRM Implementation,Case studies on Sittaung River Basin,2007
3.Statistical Year Book ,2010,Central Statistical Organisation,
Ministry of National Planning and Economic Development, Union of Myanmar.

Food Security : Comparison between World and Myanmar

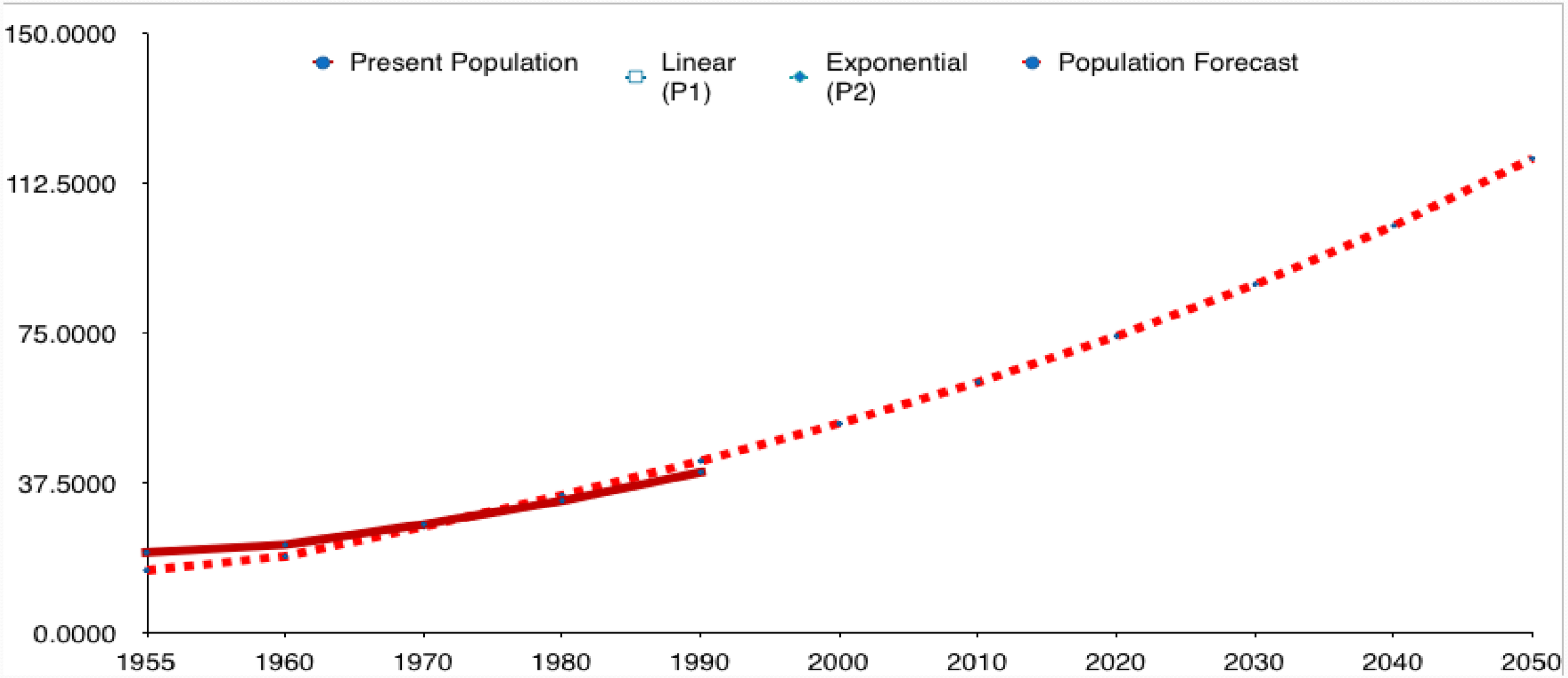
(Source:Myanmar Agriculture 2011)

Paddy Production in Asia Pacific Myanmar and Neighbouring Countries (2008)					%
Country	*Harvested Area mil.ha*	*Yield Kg/ha*	*Production Mil.MT*	*Export 1000 MT*	
World	*159*	*4307*	*686*	*33081*	*5%*
Asia	*142*	*4378*	*622*	*24943*	*4%*
Myanmar (2009-10)	*8*	*4056*	*33*	*818*	*3%*
Thailand	*10*	*2963*	*32*	*9196*	*29%*
Vietnan	*7*	*5223*	*39*	*4558*	*12%*
Indonesia	*12*	*4895*	*60*	*1.2*	*0%*
Malaysia	*0.6*	*3586*	*2*	*0.2*	*0%*
Phillippines	*4*	*3770*	*17*	*0.4*	*0%*
Lao PDR	*0.8*	*3546*	*3*		
Cambodia	*3*	*2746*	*7*	*2.6*	*0%*
China	*29*	*6556*	*193*	*1325*	*1%*
Bangladesh	*12*	*3995*	*47*	*19*	*0%*
India	*44*	*3370*	*148*	*6450*	*4%*

Food Security of Myanmar
Agricultural Policies, Objectives and Strategies

- **Myanmar Economy and Agriculture Policy**
  - Objectives and Strategies (32% of GDP,17.5%of export earning,61.2% of the labour force)
  - Policy Changes related to Crop Production
- **Policies ,Objectives and Strategies for Agricultural Sector**
- **Main Objective of MOAI**
  - Increase crop production
  - Target yield of 10 principle crops (Paddy 5.16 metric ton per hectare)
  - Measures to be undertaken for 10 principle crops
  - Agricultural short term plan
- **Five Strategies for Agricultural Development**
  - 1. Development of new agricultural land
  - 2. Provision of sufficient irrigated water
  - 3. Provision and support for agricultural mechanization
  - 4. Application of modern agro-technologies
  - 5 Development and utilization of modern varieties

Myanmar Population Vs. Paddy Production
Present Population of Myanmar & Future Population Trend in Millions



Source :

1.Present Population, Statistical Yearbook 2010

2.Population Forecast using average of linear and exponential curve fitting

Myanmar Population Vs. Paddy Production
Present Population of Myanmar & Future Population Trend in Millions

Region	Population x millions (% of Total)	Paddy Sown Acres Million Acres	Paddy Production X Mln Mt	Paddy Consumption X Mln Mt/Yr	Paddy Surplus Mln Mt
Union Total	**44.744 (100%)**	**15.166 (100%)**	**19.565 (100%)**	**15.265 (100%)**	**4.299**
1 Upland Area	22.744 **(51 %)**	4.423 **(29 %)**	4.844 **(25 %)**	7.483 **(49 %)**	-2.638
1.1 Hilly Region	7.670	1.828	1.922	2.544	-0.622
1.2 Dry Zone	15.074	2.594	2.922	4.939	-2.017
2 Lowland Area	22.000 **(49 %)**	10.743 **(71 %)**	14.720 **(75 %)**	7.781 **(51 %)**	6.938
2.1 Costal Strips	5.971	1.859	2.281	2.021	0.260
2.2 Ayeyarwaddy Delta	**16.029 (36 %)**	**8.883 (59 %)**	**12.439 (64 %)**	**5.76 (38 %)**	**6.678**

Three Rice Bowls of Asia : Characteristics of Deltas in Asia

- **Southeast Asian Deltas vs. Ayeyarwaddy Delta**

River Delta	Location	Total River Length ,Miles	Gross Area Sq. Km	Slope to the Sea
Mekong	*International*	*2700*	*55,000*	*3/100,000*
Ayeyarwaddy	*Myanmar*	*1350*	*31,000*	*5/100,000*
Red River	*Vietnam*	*750*	*15,000*	*9/100,000*
Chao Phraya	*Thailand*	*225*	*11,300*	*1/10,000*

- Tidal ranges of Southeast Asian deltas differed greatly by region.
- Mean tidal range of most Asian deltas was 9 feet on average
  - (9 feet in South Eastern Sumatra,Indonesia,)
- whereas much tidal ranges of 13.5 feet to 15 feet was found in Ayeyarwaddy delta of Myanmar .
  - (Source: A.Volker)

Three Rice Bowls of Asia
Rainfall Vs. Crop Water Requirements

Delta Name	Mean Annual Rainfall		Crop Requirement
	Growing Season	*Wet Season*	
Ayeyarwaddy	***2150 mm***	***1500 mm***	***1300 mm***
Chao Phraya	***1500 mm***	***1100 mm***	***1300 mm***
Mekong	***2000 mm***	***1400 mm***	***1300 mm***

- Facts: Ayeyarwaddy delta with excess of rain over demand has led more than a century ago to the construction of a system of partial flood protection by embankments for rice paddy cultivation in wet season of monsoon.

- (Source :A volker)

Ayeyarwaddy Delta of Myanmar
Land Use and Agriculture

Land Use

- **Very fertile land for agriculture, especially for wetland rice paddy cultivation as a staple food supply for it's ever growing population within the country and in the region beyond it's borders**

Agriculture

- **Paddy cultivation in Ayeyarwaddy delta was traditionally accomplished by monsoon rain**

Climate and Hydrogy

- **Upper reach of the delta is predominantly affected by seasonal river flood caused by upland flow and downstream tidal flow**

Ayeyarwaddy Delta of Myanmar

- Area 31,000 sq km (13,500 sq mi)
- Average Annual Flow:
  - M.15,200 cu mec
    Measured at apex of delta (Pyay)
- Total River Length
  - 2170 km (1350 miles)
- Basin Area of Ayeyarwaddy River
  - 1 60,510 sq mile (57% of the country area)
- Major river channels to the sea : 12 Nos.
- General topography :
  - more than 2,000 sq mi of area lies below maximum spring tide level
  - (suitable for tidal irrigation)
- Mean annual rainfall :2150 mm (85 inches)
- Rain fed paddy paddy cultivation areas :
  - about 728,750 hectares (= 1,800,730 acres)

Ayeyarwaddy Delta of Myanmar
Seasonal River Runoff in Ayeyarwaddy Delta

Wet season flow

- Average peak mean monthly flow ::
  - 35,000 cumec (= 1,235,064 cusec) with a variance of about 25%.
  - Generally occurs in August
- On average a flow of about 40,000 cumec is reached for a period of a week in each wet season.
- The 100 year flood discharge is about 55,000 cumecs.(historical runoff)

Dry season flow

- Mean monthly minimum upland flows:
  - about 2,500 cumec (= 88,219 cusec) for a period of 4 months between January and April when there is little or no rainfall in the delta.
  - During this period seawater intrudes into the delta.
- During the dry season the flows are contained within the banks of the channels except in the case of the saline inter-tidal mangrove swamps near the ocean.

(Source ; Odd)

Ayeyarwaddy Delta of Myanmar
Distribution of River Runoff in Lower Ayeyarwaddy

- **Ayeyarwaddy river discharge by upstream flow was recorded at Hinthada as 1,2 million cusec on average in August .**

- **During flood, Ayeyarwaddy Spilled 12 % of it's flows to Ngawun River in west bank and 25% of flow to Hlaing river in east bank .**

- **On the downstream of Hinthada ,Ayeyarwaddy river divided into Panhlaing river near Nyaungdone by 10% of it's flow into Toe river near Meethwechaung by 30%, and into downstream Ayeyarwaddy near Kwedone (Left bank) by 55% of it's flows.**

- **Additional runoff of about 0.37 million cusec from the delta catchments supplement to the upper Ayeyarwaddy flow.**

- **Flood in Ayeyarwaddy delta normally occurred during August where much rainfall in the area coincide with the much runoff from upstream Ayeyarwaddy river .**

- **The flow decreased to 82,000 cusec in March in dry season.**

- (Source: A Volker)

Developments Schemes of Ayeyarwaddy Delta Through the Ages of Paddy Production

1882-1948 Colonial Period

- Large scale flood control embankments in horseshoe shape were constructed
- Vast area of 612,000 acres of waste lands then in Henzada district in upper delta was reclaimed for rainfed paddy cultivation

1977 – 1987 Socialist Period

- The introduction of polders projects throughout the middle and lower delta
- More than 200,000 acres of fallow and waste lands in different parts of low land area of the delta were reclaimed and transformed to agricultural land again especially for rainfed paddy production
- (The projects named as the Lower Burma Paddy Land Development Projects, Phase 1 and 2 were implemented and financed by World Bank.)

Developments Schemes of Ayeyarwaddy Delta Through the Ages of Paddy Production

1990’s SPDC Period

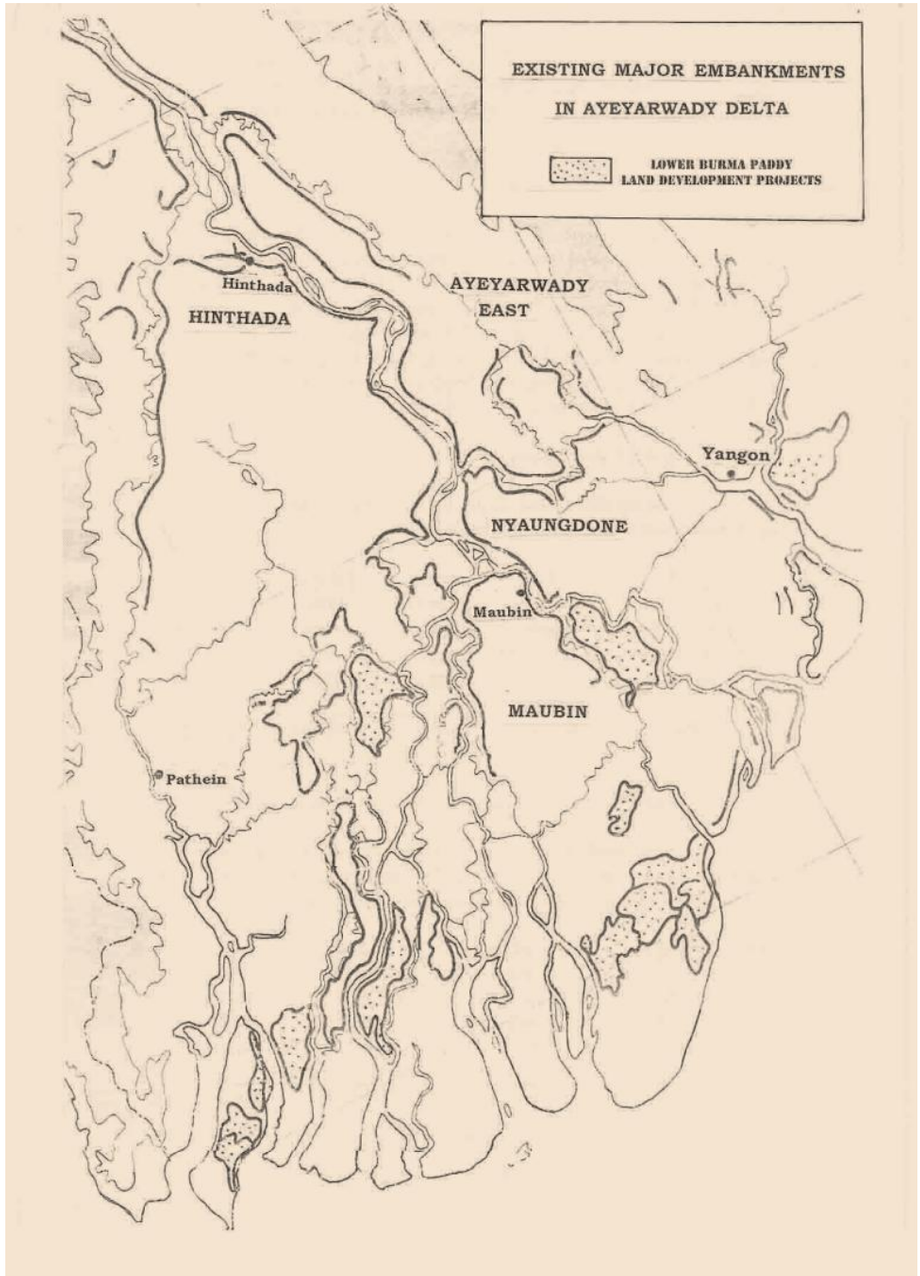
- **Modern day concept of fresh water tidal gravity irrigation was introduced in strategic places throughout the middle delta to boost summer paddy rice production of about 400,000 acres of land again**

- **(Rain-fed paddy cultivation normally done in monsoon season in the delta was supplemented by irrigated paddy cultivation in summer season by tidal gravity irrigation methods.)**

(SPDC – State Peace and Development Council)

Age of Embankments for Flood Control for Monsoon Paddy Cultivation (from 1882 to 2010):

Construction of Flood Control Embankments in Ayeyarwaddy Delta



Total numbers of embankments constructed in Ayeyarwaddy delta:

69 nos

Total Length. **21,590 kilometres**
(13,416 miles)

Total protected cropland areas against flooding and saline intrusion during the monsoon season **668,340 hactares**
(1,651,500 acres-)

These embankments protected about 28 % of agriculture land in Ayeyarwaddy Delta (2.4 million ha)

(Source ; ID,Ayeyarwaddy)

Flood protected Areas in AYEYARWADDY Delta (2002-2003) (in thousands)

- Protected Areas by Embankments

Location	Hectare	Acre	% of Myanmar
Myanmar	1212	2995	100%
Delta	1144	2827	94%

- Delta

Division	Hectare	Acre	% of Delta
Bago	244	603	21%
Yangon	140	346	12%
Ayeyarwaddy	760	1878	67%

- Source: MOAI, Irrigation Department

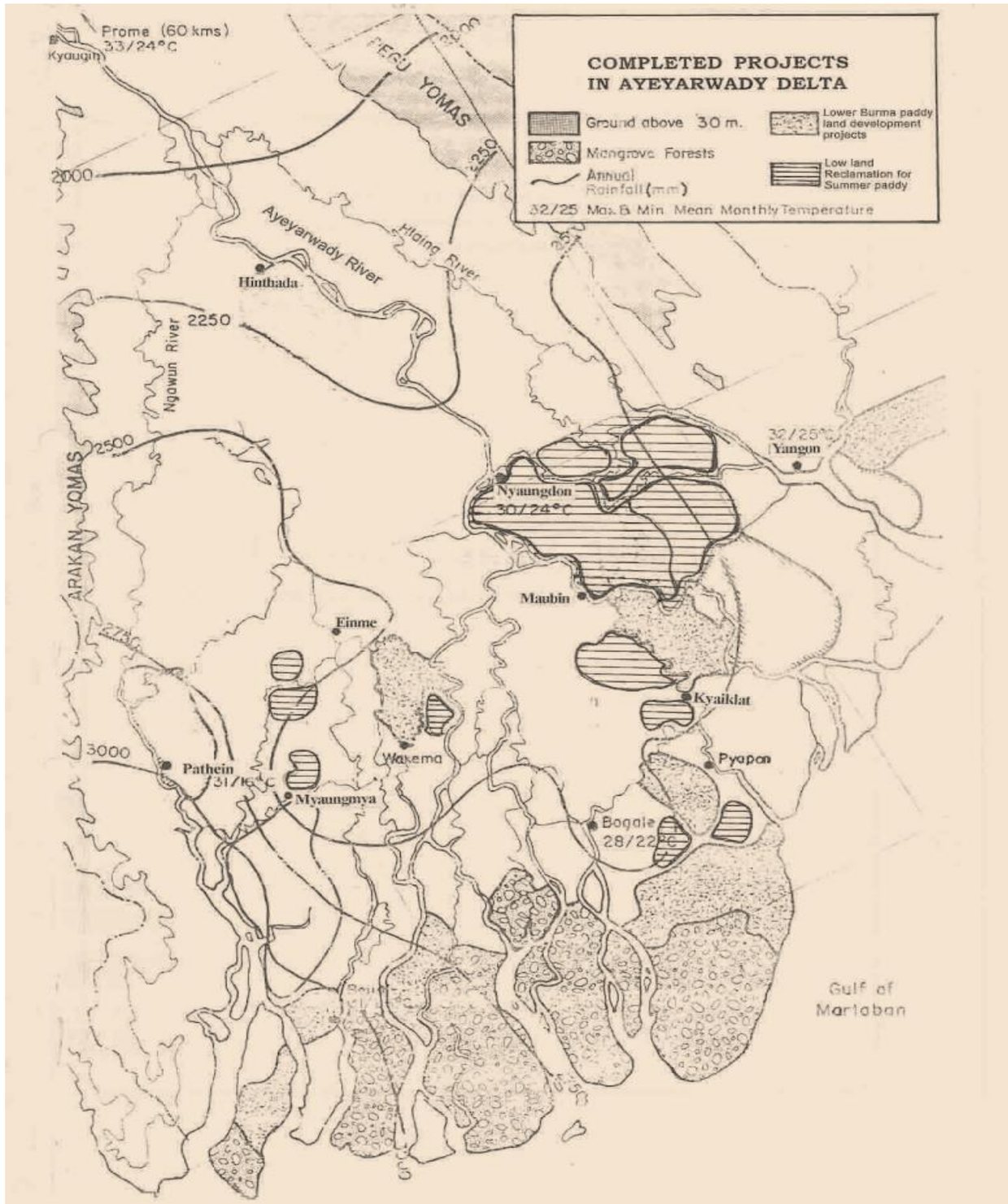
Construction of Embankments for Flood Control In Ayeyarwaddy Deta through the Ages

Period	year	Major works numbers	Length in miles	%Total	Protected Area in acres	%Total
Colonial	-1948	10	418.5	31%	1,121,300	68 %
Palimentary	1948-62	14	196.2	15 %	171,400	10 %
Socialist	1962-88	43	667.6	50 %	332,400	20 %
SPDC	1988-2010	2	59.3	4 %	26,400	2 %
TOTAL		69	1,341.6	100 %	1,651,500	100 %

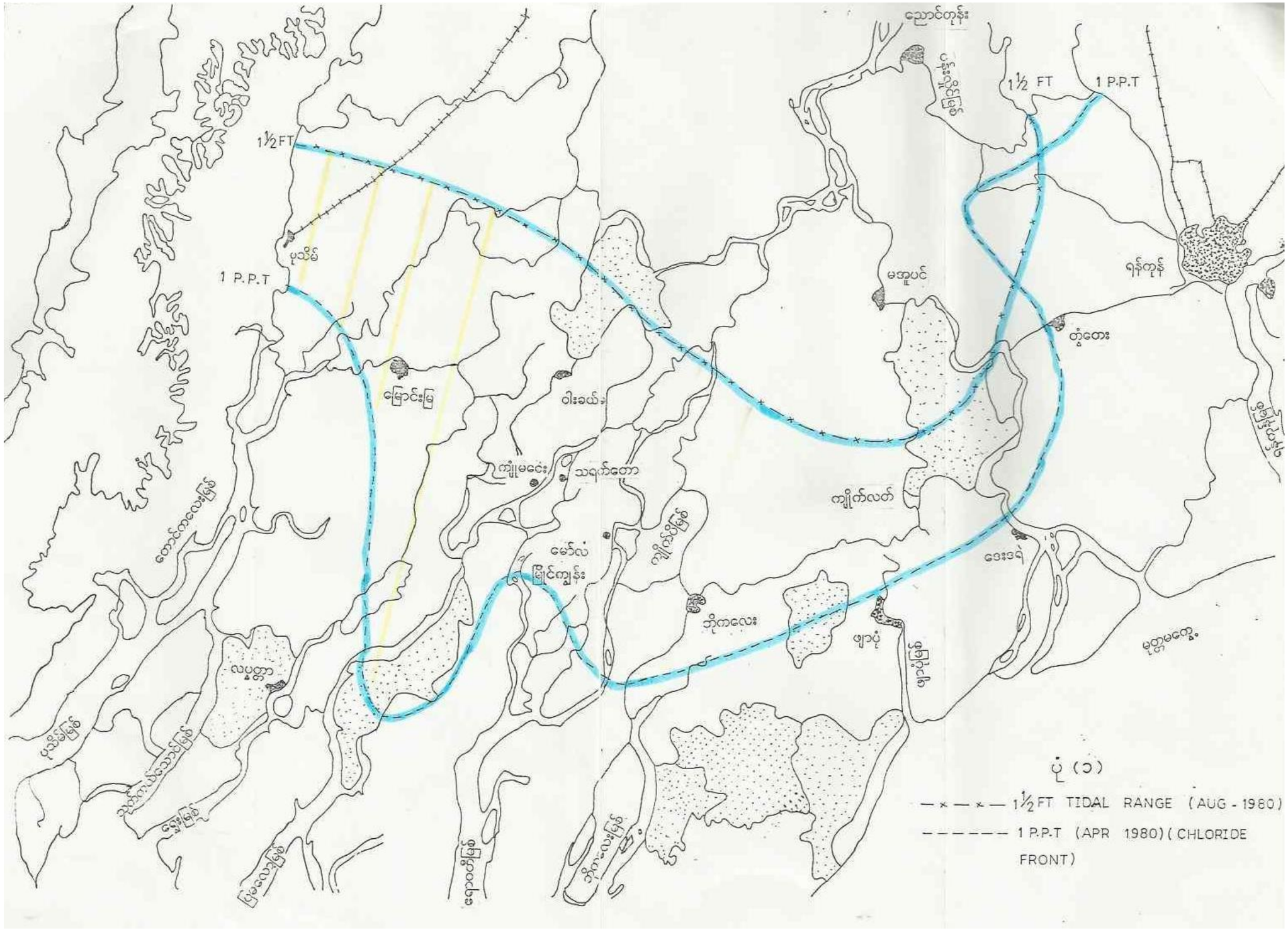
(Source ; ID,Ayeyarwaddy)

Age of Polders for Flood Control and Drainage

Implementation of Lower Burma Paddyland Development Projects, Phase I and II , financed by World Bank. from 1977 to 1990 for Monsoon Paddy Cultivation



Fresh Water Availability of the Ayeyarwaddy Delta For the Tidal Irrigation Projects in Delta



Water Management in Ayeyarwaddy Delta : Major Hydraulic Infrastructures

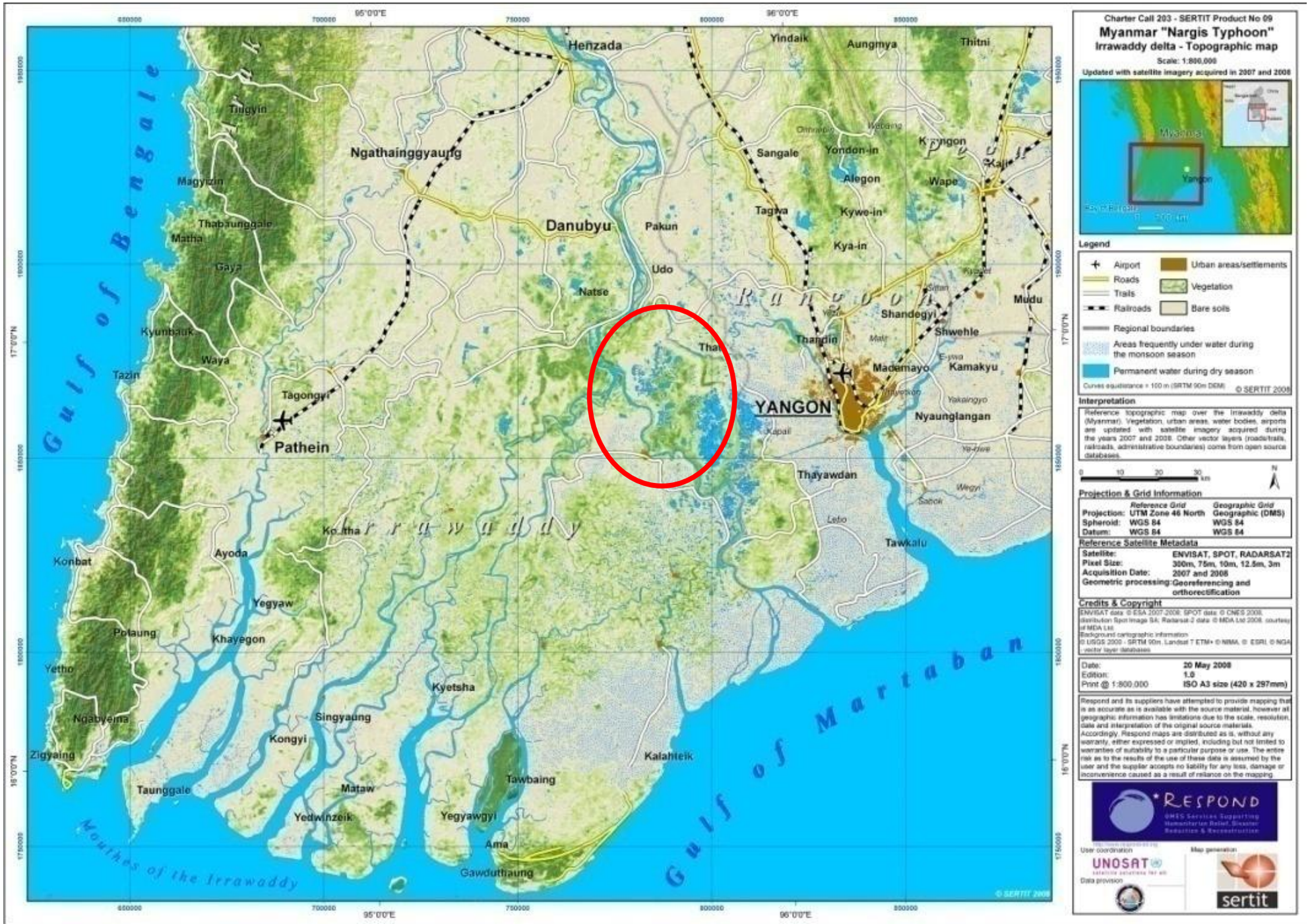
- **Sluice Gates**
  - **For Tidal Irrigation**
  - **And Drainage**
- **Lock Gates**
  - **For Navigation**

Tidal Irrigation and Drainage Sluice in Delta

- A Typical Tidal Irrigation and Drainage Sluice in Low Land Ayeyarwaddy Delta of Myanmar

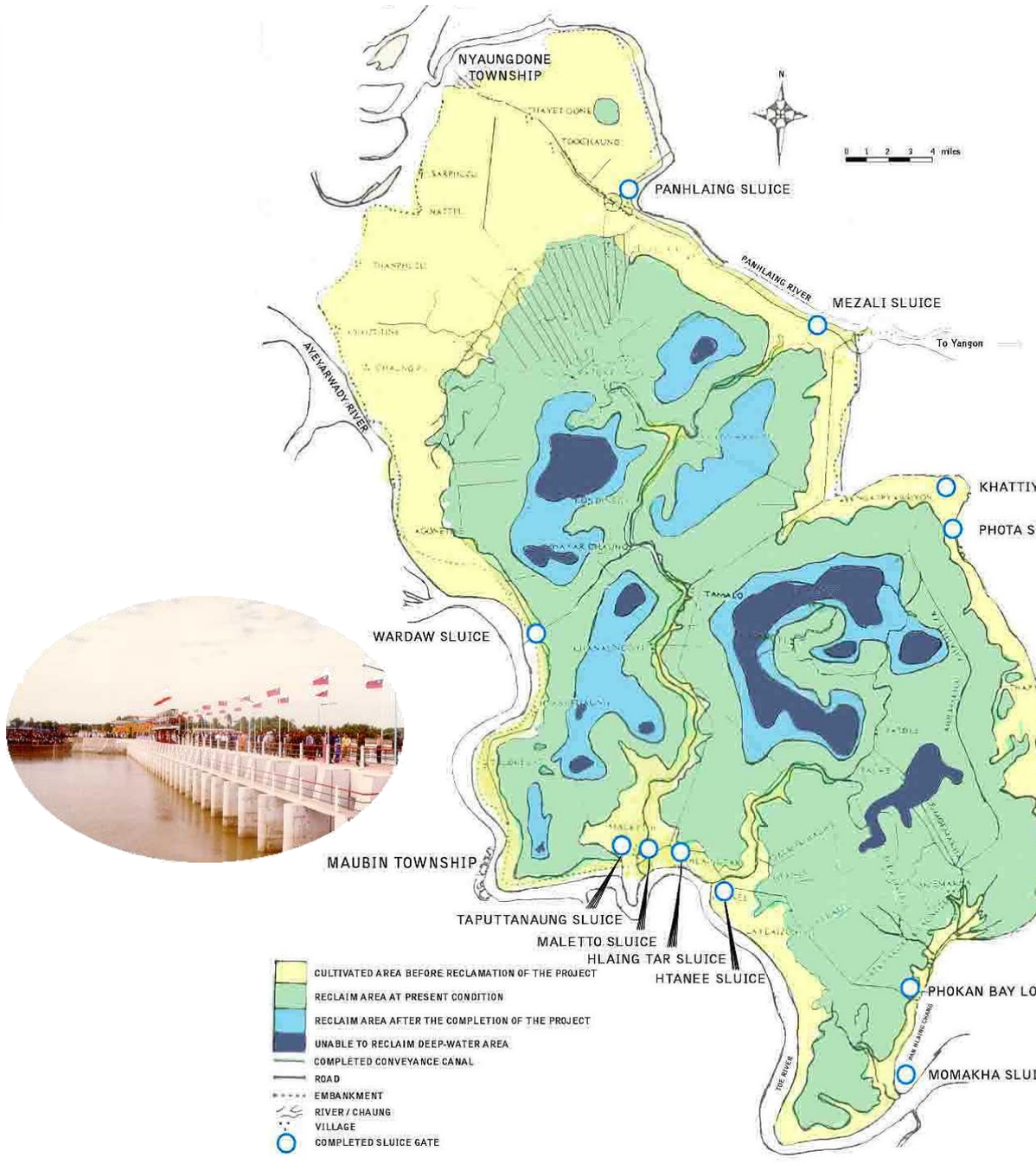
A Typical Tidal Irrigation and Drainage Sluices Constructed In Ayeyarwaddy Delta of Myanmar

Some of the Tidal Irrigation Works Implemented in Ayeyarwaddy Delta during 1990s :
Case Study : Nyaungdone Island in Ayeyarwaddy Delta



Case Studies : Layout Plan of Nyaungdone Island Reclamation Project

Land Development Area	Area Acre	Area Hectare
Cultivatable area before the project	75990	30752
Area already reclaimed and added to the cultivable area	71220	28822
Area under reclamation with project	38600	25621
Un-reclaimable area left for ecological purpose	4600	1861



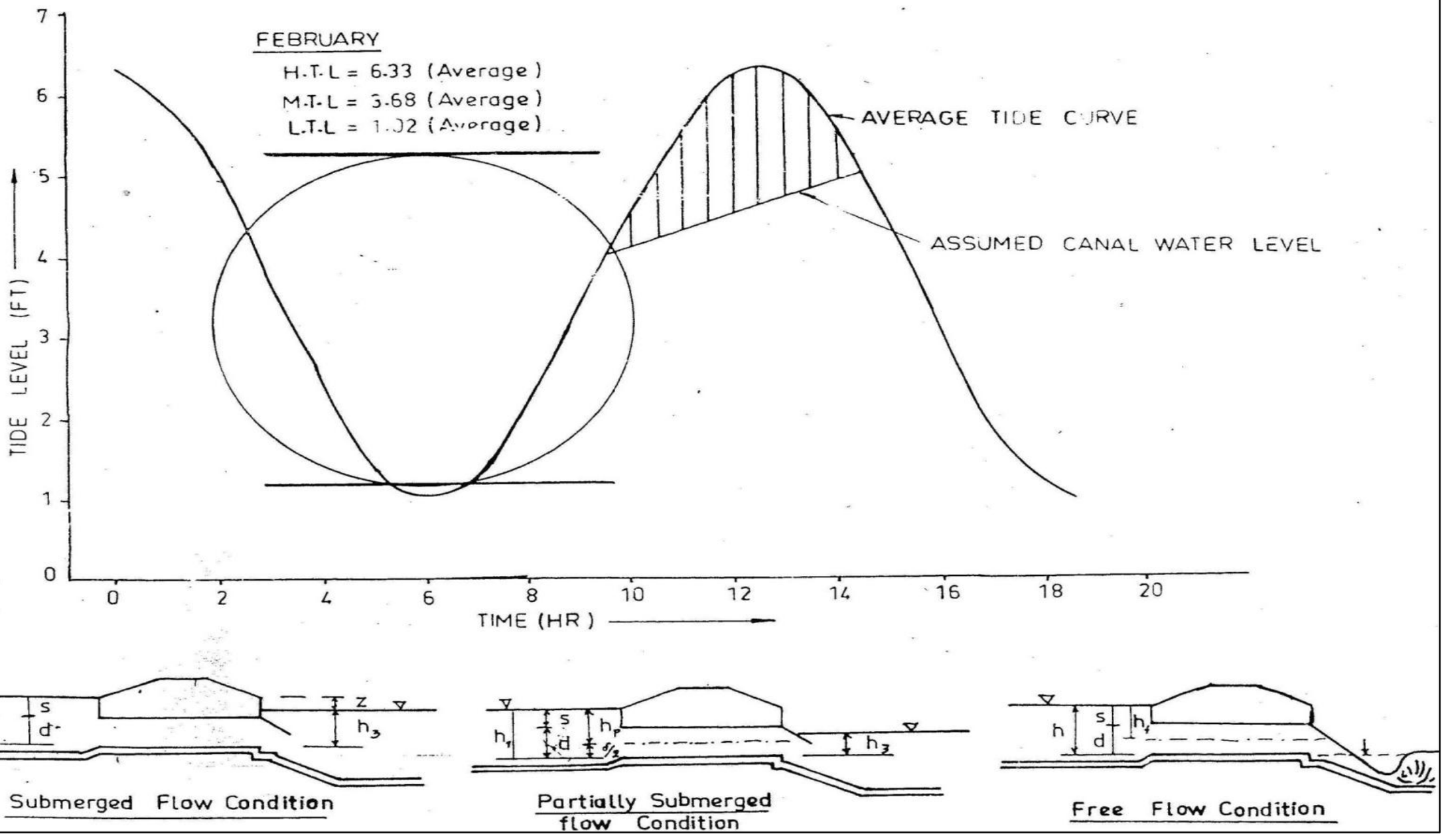
Tidal Irrigation in Nyaungdone Island : Design Concept

- **When river water level is higher than the ground level in the polder at high tide, it is effective in irrigation;**
- **When river water level is lower than the water level in the polder at low tide, it is effective in drainage.**
- **Dry season irrigation water could be increased as much as required;**
  - **by increasing the number of sluices and**
  - **by increasing the number of openings.**
- **It also increases drainage capacity by the same structure**
- **The sluice serves as irrigation as well as drainage.**

Stylised Design Tide Curve for Tidal Irrigation

FIGURE (5)

STYLISED DESIGN TIDE CURVE

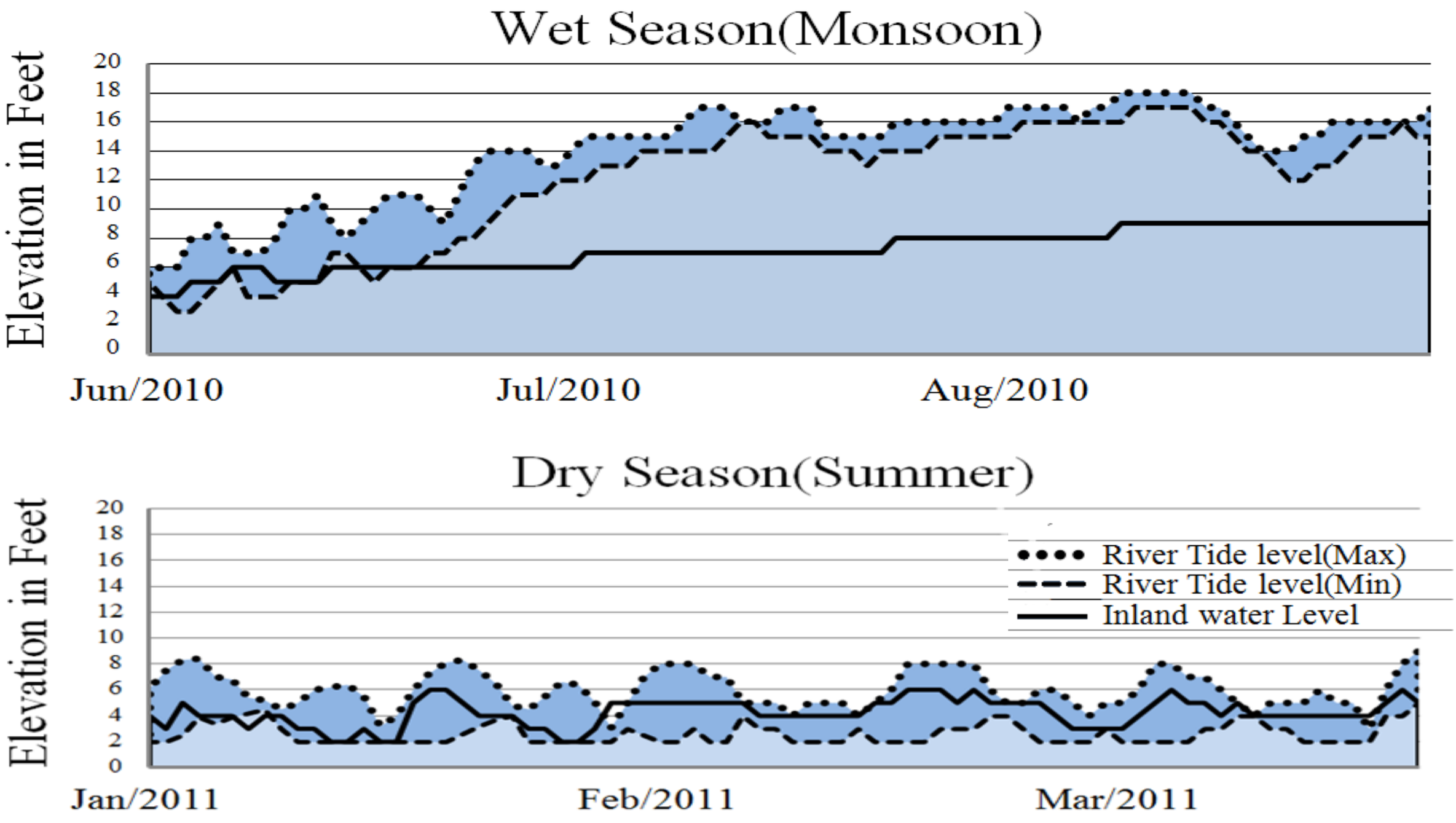


Submerged Flow Condition

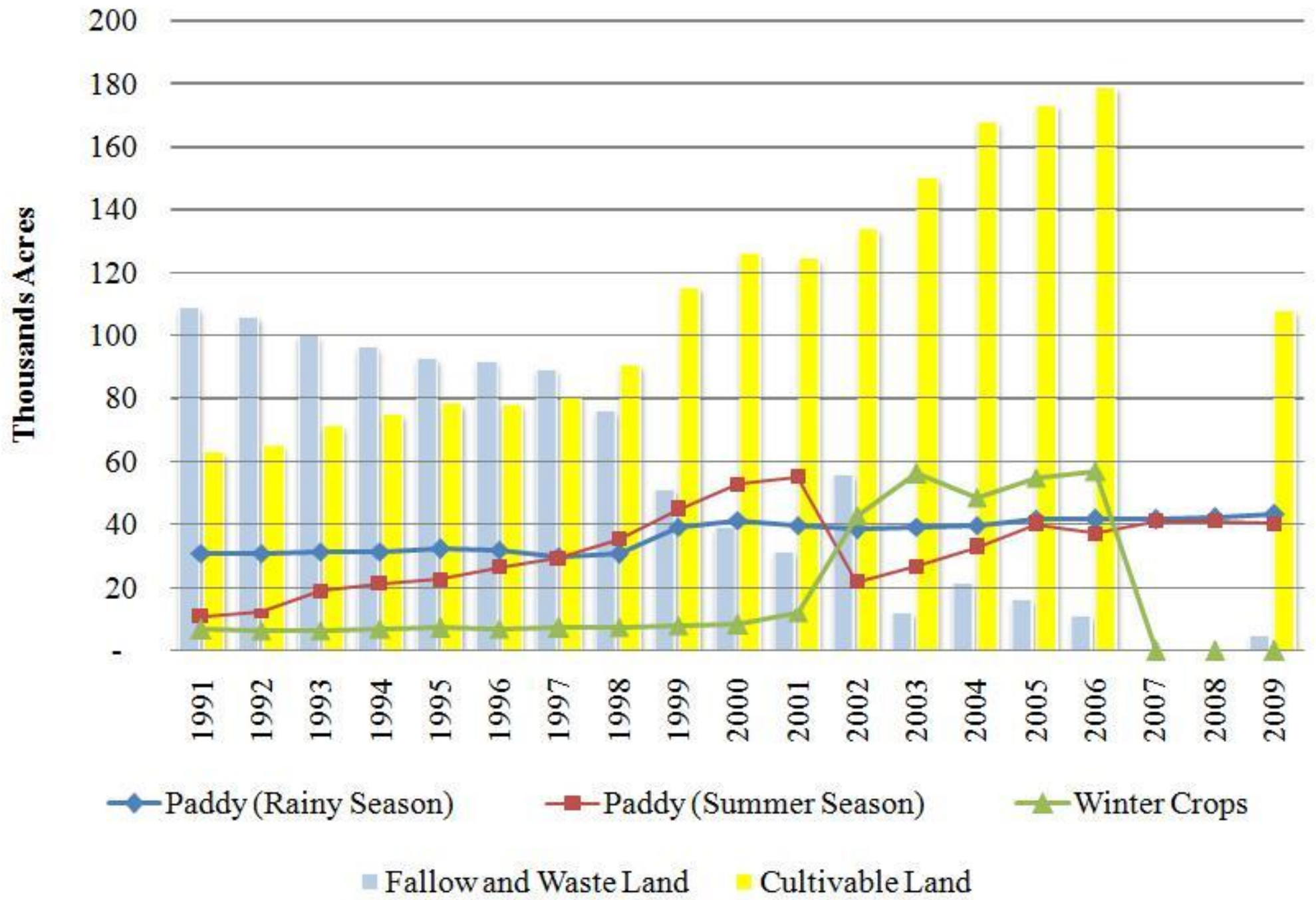
Partially Submerged flow Condition

Free Flow Condition

River Water Level and Inland Water Level in Monsoon at Mezali Sluice



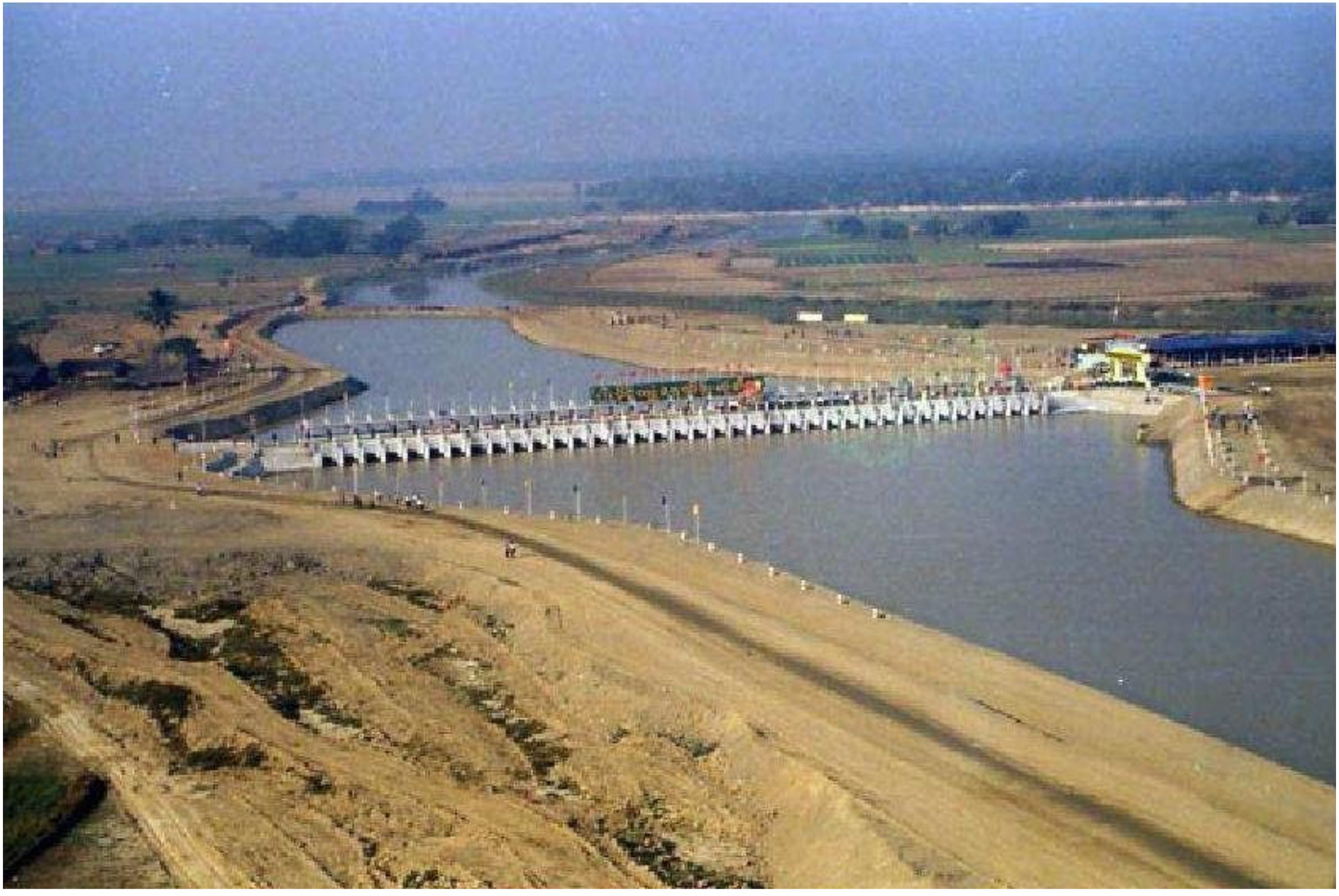
Land Use and Crop Area Change
In Nyaungdone Island from 1991 to 2009



Some Noval Aspects of Sluices In Tidal Irrigation Projects

- **A novel aspect of the tidal irrigation project is that sluices constructed around the island had double functions**
- **The same structure can be used as irrigation facilities as well as drainage, direction of water current reversible according to the tidal flow.**
- **Irrigation at high tide level and drainage at low tide level whenever and whichever is desirable**
- **Same is true that canals were functioning drainage as well as irrigation according to season**
- **Since tide is astronomical phenomena, it is always dependable with assured supply of water,**
- **In comparison, reservoir in dam project depends on weather, i.e. the rain which is variable from year to year and even unpredictable rainfall pattern may encountered in a time of climate change.**

Aerial View of a Typical Drainage and Irrigation Sluice In Ayeyarwaddy Delta of Myanmar



Paddy and Fish Production of Ayeyarwaddy Delta Vs. Myanmar In 1995-1996

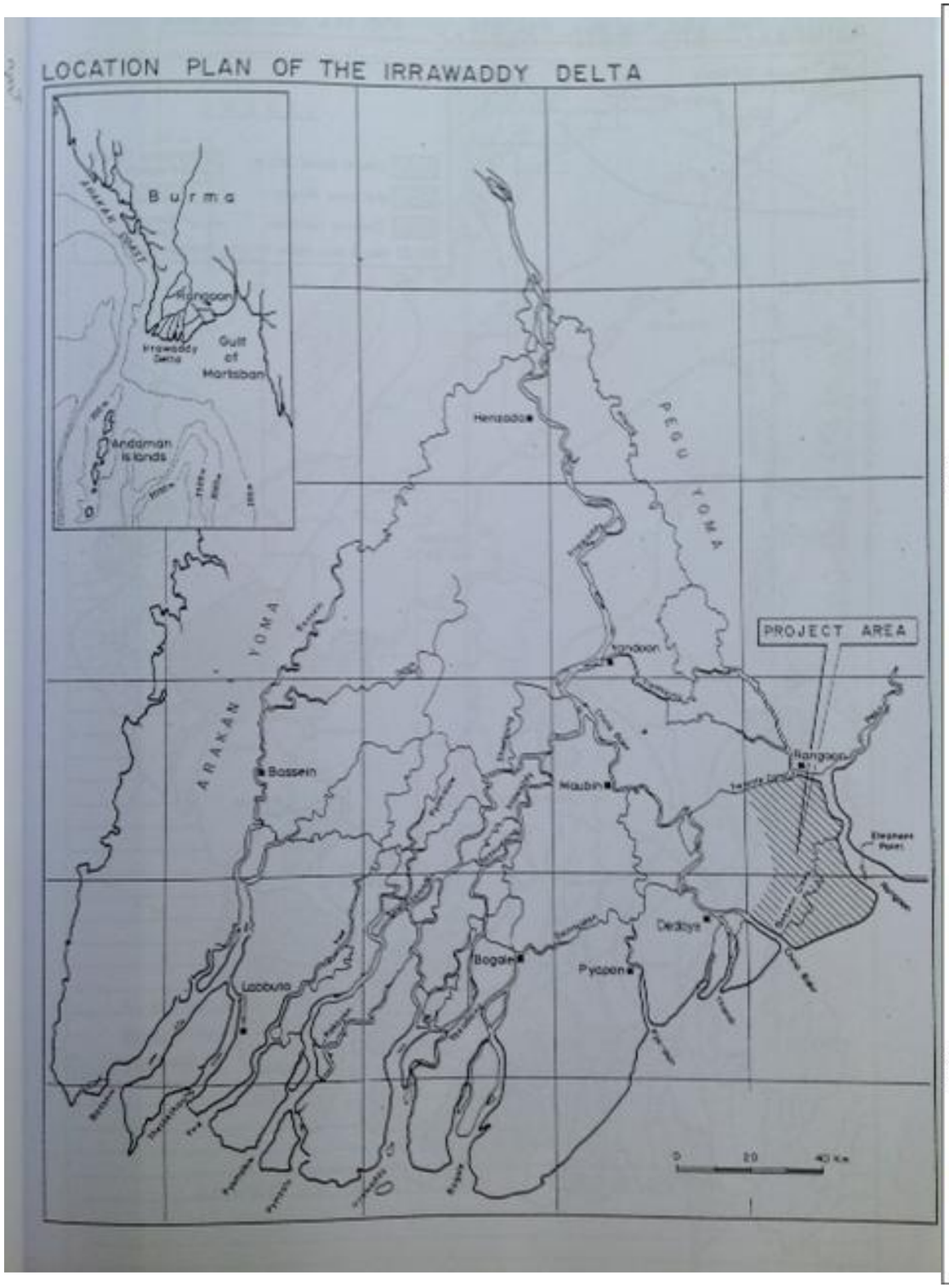
Particular	Unit	Upland	Lowland	Union Total	Ayeyarwaddy Delta	% of Union
Gross Area	Sq Miles	192,836	68,392	261,228	32,728	12 %
Population	Million	22.744	22.000	44.744	16.029	36 %
Population Density	Person Per Sq Mile	118	322	171	490	
Paddy Sown Area	Million Acres	4.423	10.743	15.166	8.883	59 %
(% of Gross Area)	%	3.6 %	24.5 %	9.1 %	42.4 %	
Yield	Basket Per Acre	49.89	57.95	53.92	60.70	
Paddy Production	x Million Ton	4.844	14.720	19.565	12.439	64 %
Paddy Consumption	x Million Ton	7.483	7.781	15.265	5.760	38 %
Paddy Surplus	x Million Ton	2.639	6.93	4.300	6.678	
Fish Production	X Million Viss	30.423	380.740	411.163	211.157	51 %
	x Million Mton			0..671	0.345	

Future Blue Water Resources Development Potential In Ayeyarwaddy Delta to Boost Paddy Production

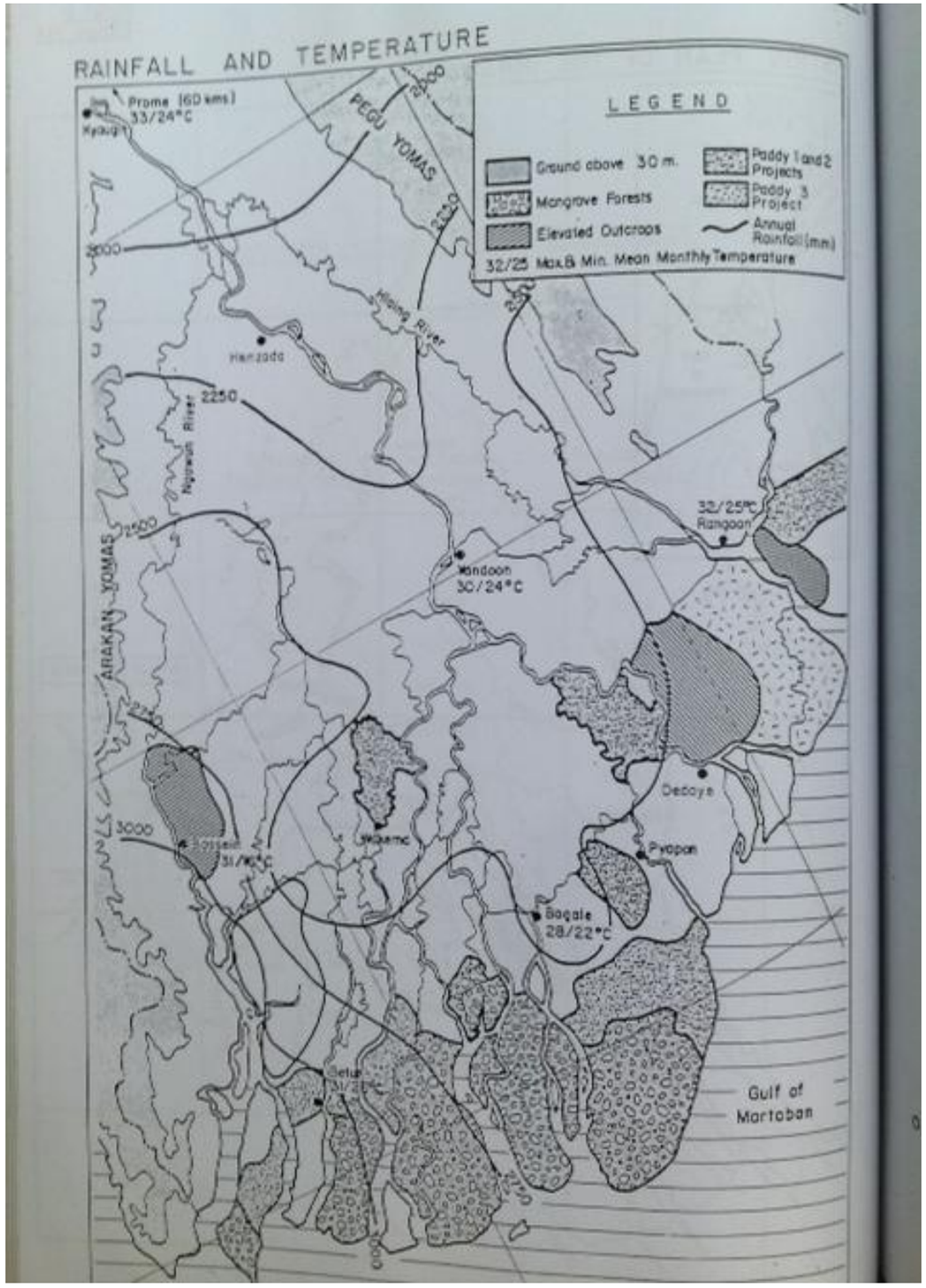
- **The Ayeyarwaddy Delta and lt's Water Management Developments schemes for flood control, drainage and reclamation for paddy production**
  - **There still remained potential areas in the delta that can be developed by empoldering works for paddy cultivation**
  - **There also remain areas with tremendous potential for tidal gravity irrigation in Ayeyarwaddy Delta**

- **Based on the past experiences of water management schemes in the delta, improved and future extension of the areas for paddy production can be established by best uses of land and blue water resources in Ayeyarwaddy delta of Myanmar.**
  - **One example is the development of integrated water resources management schemes, Paddy Land Development Project (3) in southern part of Yangon City, previously formulated by World Bank in 1982.**

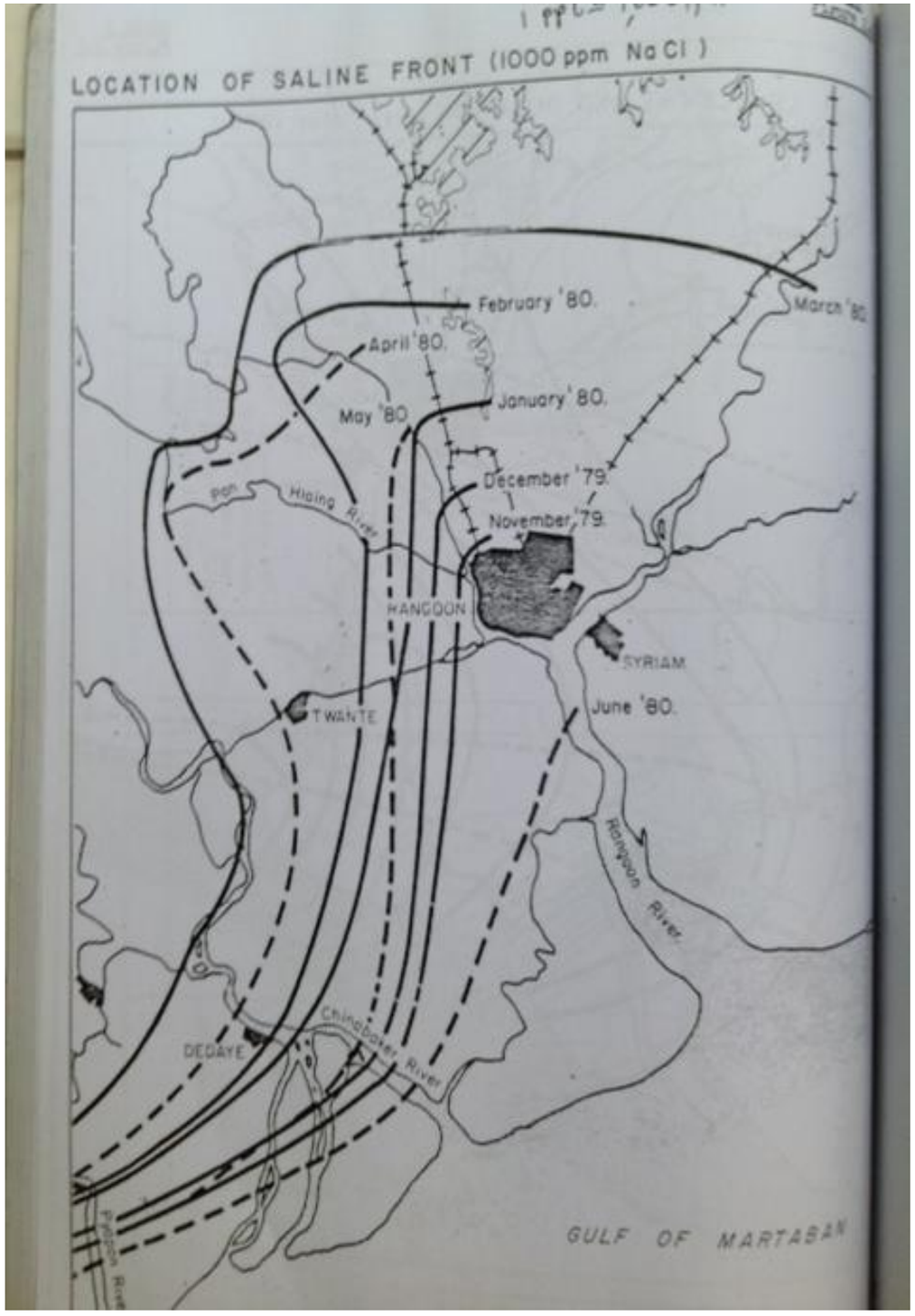
Location of Paddy 3 Project Area in Ayeyarwaddy Delta



Rainfall in Paddy 3 Project Area



Salinity Front on Paddy 3 Project Area



The Integrated Water Resources Development In Southern Part of Yangon District

Lower Myanmar Paddylands Development Phase III

- **Purpose**
  - **Flood Control, Drainage, Reclamation**
  - **Water Supply in Salt Intruded Area of Twontay, Dala, Kawhmu and Kungyangone Townships**
- **Background of the Project**
  - **Location**
    - **Lower Ayeyarwaddy delta, immediately to the southwest of Yangon**
    - **Comprised of two sizable polders**
  - **Project Area**
    - **237500 acres gross would be improved**
  - **Areas to be reclaimed**
    - **About 20000 acres of deeply flooded fallow land and saline scrubland**
  - **Time lines**
    - **February 1982 – Project Identification by FAO and Government of Myanmar**
    - **24 November 1982 – Report of FAO Project Preparation Mission (Report No. 58/82 CP-BUR 20)**
    - **March 1983 – Final Project Preparation Report completed by FAO/CP**

Lower Myanmar Paddylands Development Phase III
Main Project Components of Structural Measures

- **Main Project Components of Structural Measures**
  - **The construction of new embankments to prevent flood control and salt intrusion**
  - **Construction of all weather roads, farm roads and new bridges for canal and creek crossing**
  - **The excavation of new major drainage as well as irrigation channels and resectioning and realignment of existing channels**
  - **In addition, the construction of major inter connector channels would provide fresh water and water transport**
  - **The excavation of minor feeder drainage and irrigation canals**
  - **Construction of main drainage sluice structures, of which some structures have provision for tidal irrigation water supply**
  - **The closing of same major and minor tidal creeks**
  - **The preliminary project cost estimates 30.22 million USD at 1982 price level**

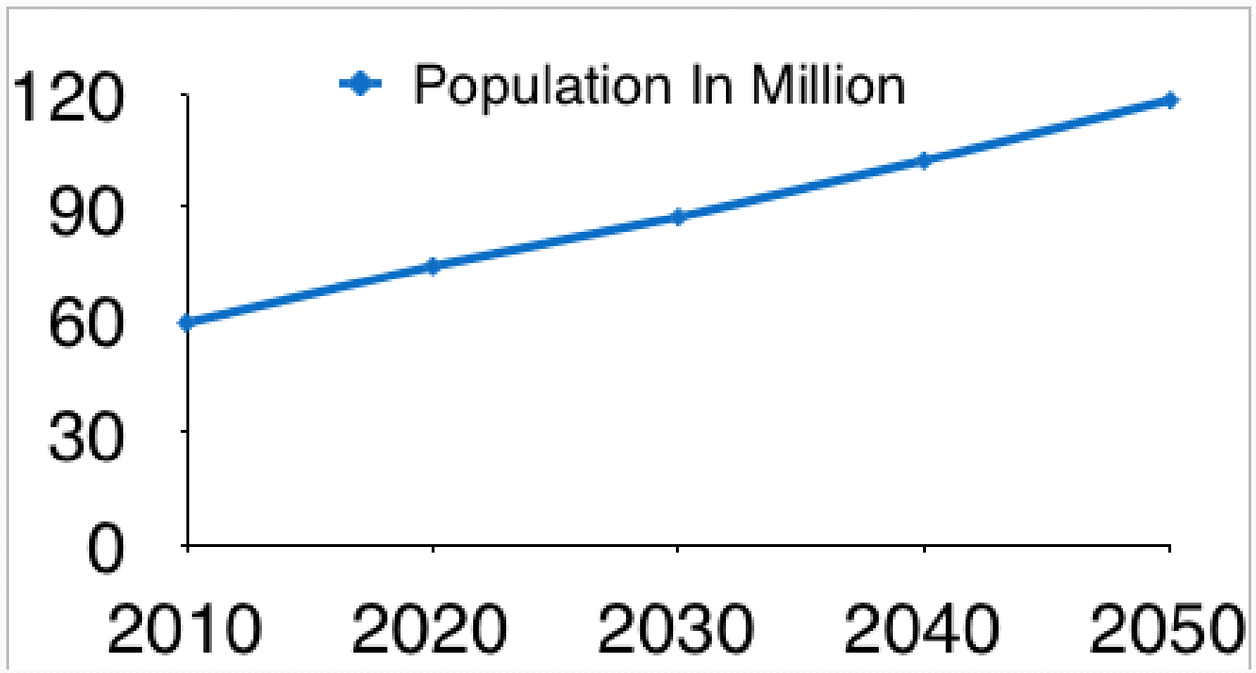
Lower Myanmar Paddylands Development Phase III
Project Benefits/Land Use

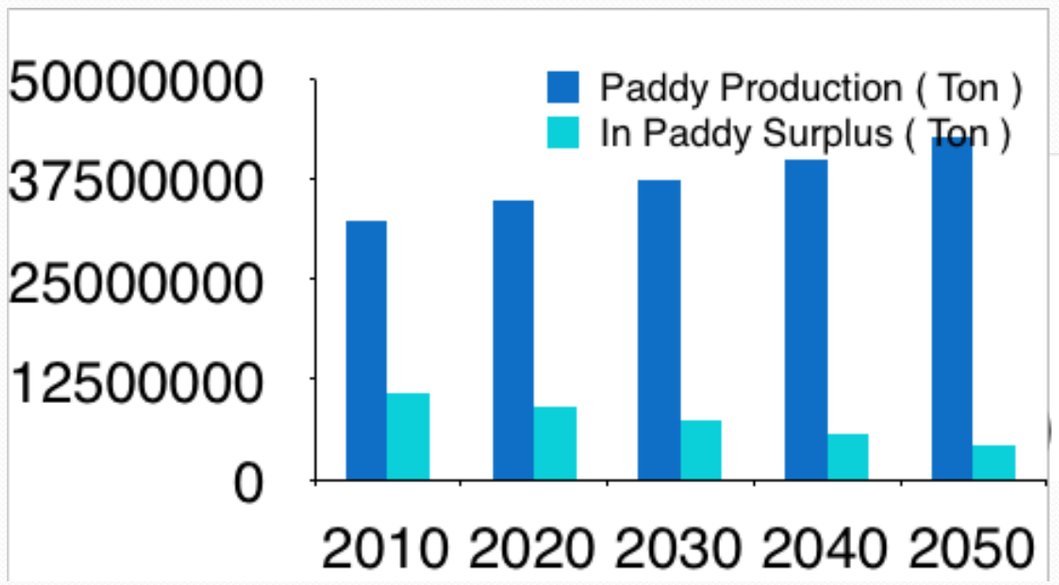
- **The project would significantly alleviate the flooding and drainage problems of the area so that paddy production in previously flooded areas can be improved by the project.**
- **The followings are previously flooded areas that can be improved**

Land Type	Area (Acres)
Flooded free/shallow flooded paddy land (HYV)	*126,800*
Medium flooded paddy land (LV)	*71500*
Deep flooded paddy land	*13000*
Very deeply flooded fallow land	*13000*
Flantings, grazing, etc	*1000*
Saline scrubland	*4000*
Loss of area due to project	*-*
Villages, roads, creeks, etc	*237500*

Future Population Vs Food Security in Myanmar
Expected Myanmar Population Vs Paddy Production

Year	Population In Million	Paddy Sown Area (Acre)	Paddy Yield (Basket)	Paddy Production （ Ton ）	Rice Consumption (Basket)	In Paddy Surplus (Ton)
2010	59	19932702	79	32337250	413910000	10798169
2020	74	20431020	83	34802965	497039498	9043087
2030	87	20929337	87	37349523	580168996	7366738
2040	102	21427655	91	39976925	663298493	5769124
2050	118	21925972	95	42685169	746427991	4250244





Future Population Vs Food Security in Myanmar
Forecast of Paddy Rice Production in Myanmar for 2050

Year	Population x Million	Paddy Sown Acres Mln Hactres (Mln Acres)	Paddy Expected Yield Mt per Hactre (Bascket/Acre)	Paddy Production Million Mt (Million Bsk)	Rice Consumption Mt per Year (Basket/Yr)	Rice Surplus Mln Mt (Mln Bsk)
2010	**59.130**	**7.973** (19.932)	**4.053** (79.00)	**32.337** (1,574.683)	(413.910)	**10.798** (215.963)
2020	**74.042**	**8.172** (20.431)	**4.255** (82.95)	**34.802** (1,694.753)	(497.039)	**9.043** (180.861)
2030	**86.972**	**8.372** (20.929)	**4.58** (86.90)	**37.349** (1,818.759)	(580,169)	**7.366** (147.334)
2040	**101.657**	**8.571** (21.427)	**4.661** (90.85)	**39.976** (1,946.702)	(663.298)	**5.769** (115.382)
2050	**118.481**	**8.770** (21.926)	**4.863** (94.80)	**42.684** (2,078.582 **)**	(746.427)	**4.250** (85.005)

Notes:1.Population forecast is based on average of linear and exponential curve fittings of 44 years of population data from 1953 to 1996.

2.Paddy sown acres is expected to increase by 10% in 2050.

3.Paddy yield ,baskets per acre is expected to increased by 20% in 2050.

4.Rice consumption is assumed to decrease by 10% in 2050 from 7 baskets/ cap/yearr in 2010

Worldwide Paddy Production Forecast , 2030
Facts and Figures

•***Production and Yield***

Forecasted annual rate of growth for paddy rice production ,550,912 ± 351,843 Mt
over the coming years

Forecasted total world production by 2030 **8.4647 to -9.1511*10*8 Mt**

Projected Asia Production **5.9996 to -7.7366*10*8 Mt**

% Production Asia to World. **71% to 85%**

equivalent % increase based on the current value 29.9% to -40.5%.

Paddy rice yield increase by 2030:		**Developing Countries**	**Asia**	**Developed**
Countries	%increase.	24.7 to-35.5%	11.7% to-23.4%	4.0% to 23.1%
	Yield	5.28 to -5.73 Mt/ha.	4.59- to 5.08 Mt/ha	
	Yield , Europe		7.66-9.75 Mt /ha	
	Oceania		8.82-12.47 Mt/ha	
	and North & Central America		7.49-8.29 Mt	

Estimated annual growth rate of Paddy rice production	Annual	+% by 2030
in developing countries	**9,476,885 Mt/Yr,**	**30.9 to -41.8%**
developed countries	**74,027 Mt/yr.**	**7.6- to 21.0%**

.

With a projected production , Asia is forecasted to be still the major region for paddy rice production in the world.

Developed countries have higher annual rates in paddy rice yield,
But the production in these regions is expected tobe lower than Asia

Pdady Production Forecast of the World Vs. Myanmar By 2030

Region	**Yield**	**Production**
Unit	Mt/Ha	Million Mt
World		846.47 to -915.11 *10*6 Mt
Developing Countries	5.28 to -5.73 Mt/ha	
--Asia	4.59- to 5.08 Mt/ha	599.96 to -773.66*10*6 Mt
% Production of Asia to the World		**71% to 85%**
-- Myanmar	**4.458 Mt/ha**	**37.349 Mt**
% Production to Asia		**6%**
-- Ayeyarwaddy Delta (expected)	5.00 Mt/ha x 4 million ha =	**20.000** *10*6 Mt
%Production to Myanmar		**54%**
Developed Countries		
-Europe	7.66-9.75 Mt /ha	
- Oceania	8.82-12.47 Mt/ha	
-North & Central America	7.49-8.29 Mt /ha	

(Source:: Wen Jun ZHANG ,assessed on 15 August 2012)

Present Ayeyarwaddy Delta : Challenges, Impacts, and Prospects

Present Ayeyarwaddy Delta:
Challenges and Climate Change Impacts,
Past Cyclone Nargis and Present Flood in Ayeyarwaddy Delta

Average Changes of Rainfall (%) in Ayeyarwaddy and Yangon Division with relative to the baesline (1961 – 1990)

Period	State and Division	+/- Changes in Rainfall (%)		
		Pre Monsoon	Peak Monsoon	Late Monsoon
2010-2039	**Ayeyarwaddy**	**-5.73**	**+ 13.65**	**+ 8.14**
2040-2069	Ayeyarwaddy	+ 29.62	+ 34.20	-5.43
2070-2099	Ayeyarwaddy	+ 7.08	+ 5.87	+ 1.10
2010-2039	**Yangon**	**+ 8.25**	**+ 2.08**	**+ 0.47**
2040-2069	Yangon	+ 3.50	+ 11.52	-1.41
2070-2099	Yangon	+ 40.12	+ 25.72	-9.73

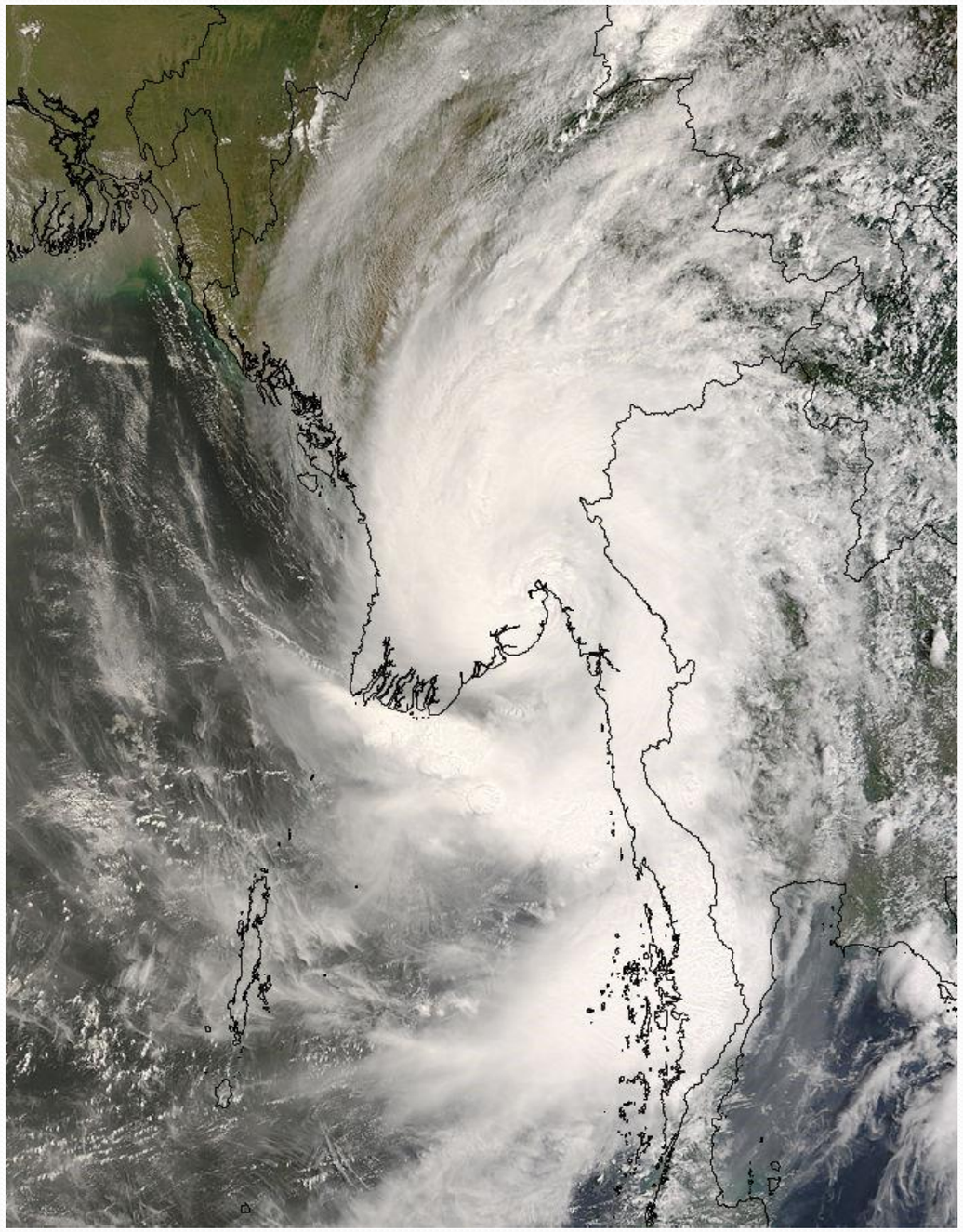
(Source:DMH,Myanmar)

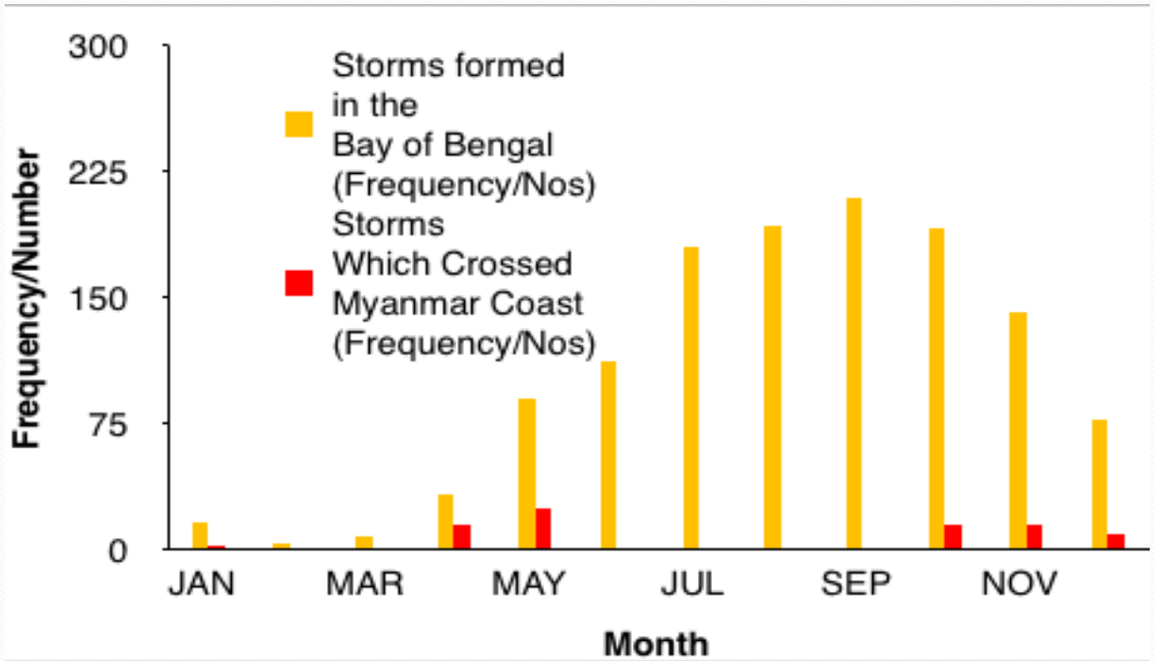
Present Ayeyarwaddy Delta
Challenges, Impacts and Prospects

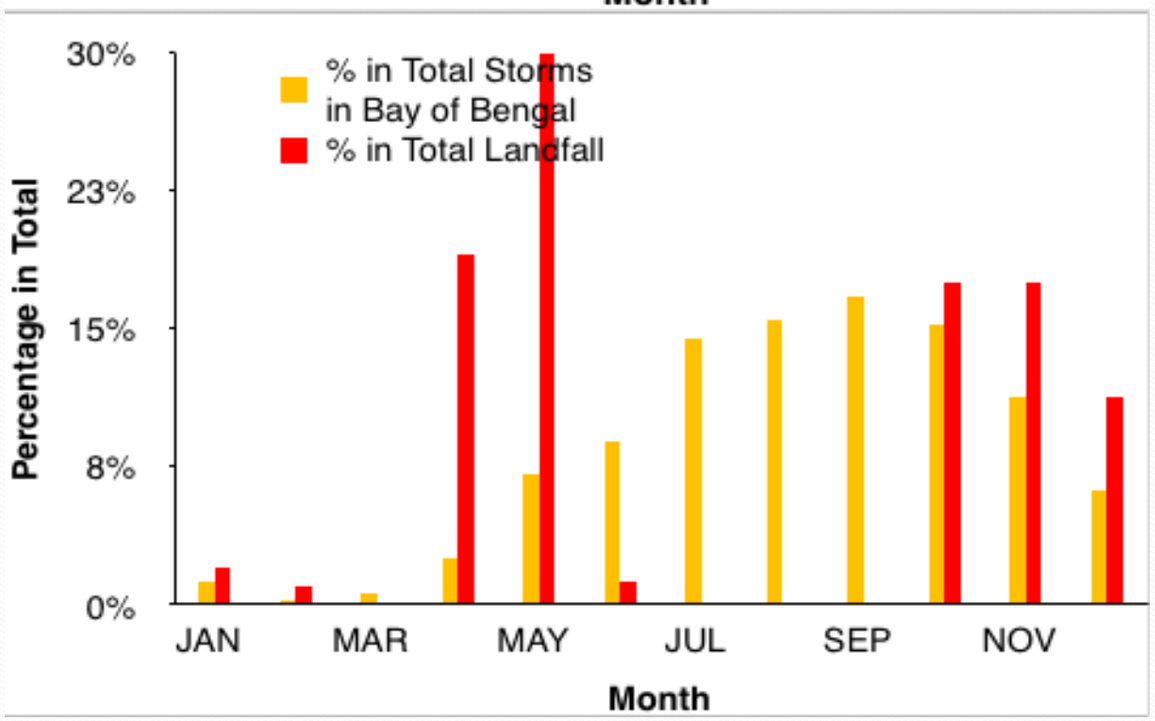
- **Natural Disasters in Delta : Storms in Bay of Bengal during 1887 to 2008**
- Total Number of Storms (%) formed in the bay of Bengal and that crossed Myanmar coast during the period 1887 to 2006
- **Remarks : May is one of the storm month for Myanmar possibility of 30% chance of land crossing**

Month	Storms formed in the Bay of Bengal (Frequency/Nos)	% in Total Storms in Bay of Bengal	Storms Which Crossed Myanmar Coast (Frequency/Nos)	% in Total Landfall
JAN	16	1%	2	2%
FEB	3	0%	1	1%
MAR	8	1%	-	
APR	32	3%	15	19%
MAY	89	7%	24	30%
JUN	111	9%	1	1%
JUL	180	14%	-	
AUG	192	15%	-	
SEP	209	17%	-	
OCT	190	15%	14	18%
NOV	141	11%	14	18%
DEC	77	6%	9	11%
Total	1248	100%	80	100%

Natural Disasters in Ayeyarwaddy Delta
Storms in Bay of Bengal From 1887 to 2008



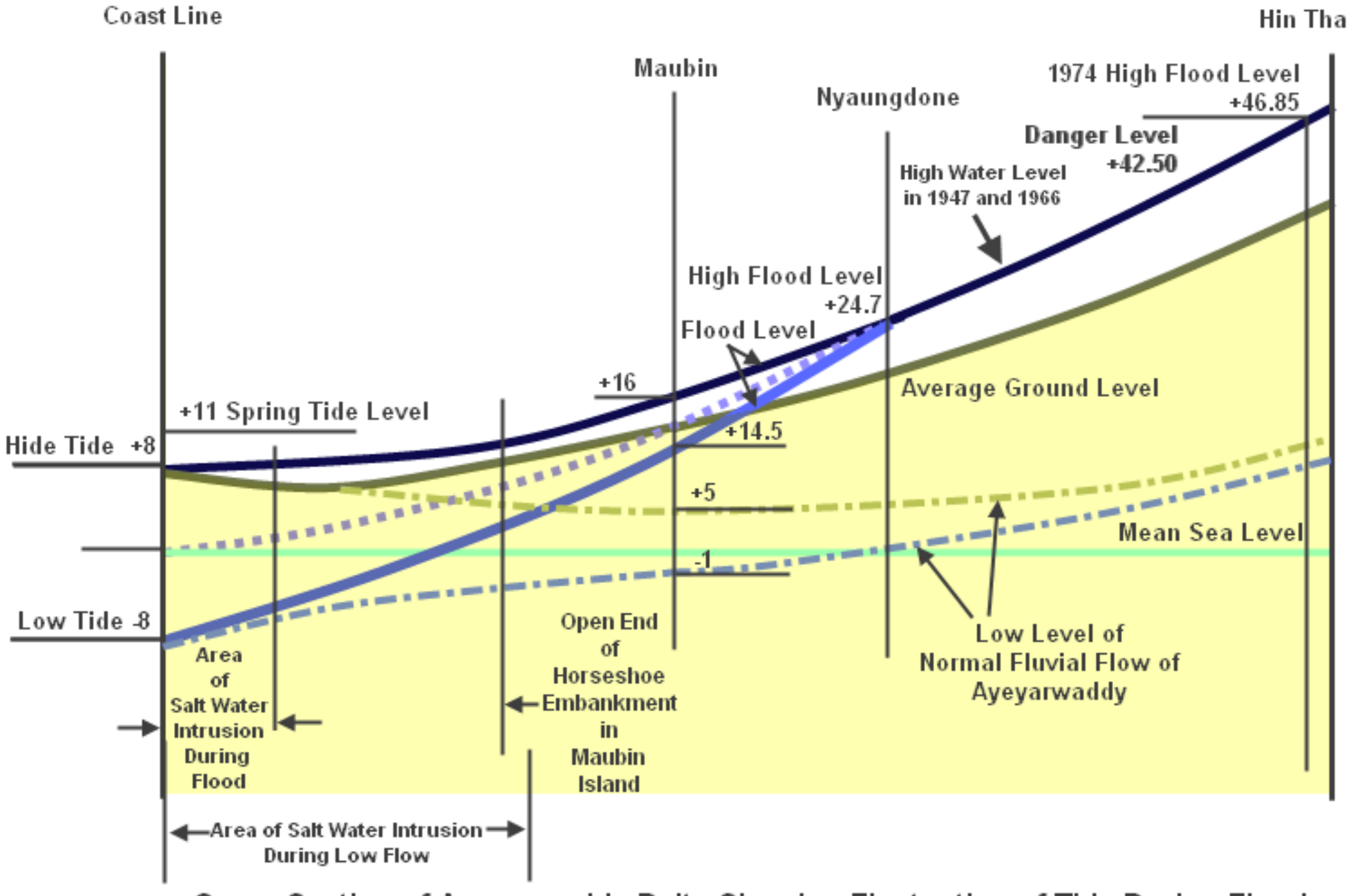




Natural Disasters in Ayeyarwaddy Delta : Great Flood of 1974
Damages and Losses in Agricultural Sector

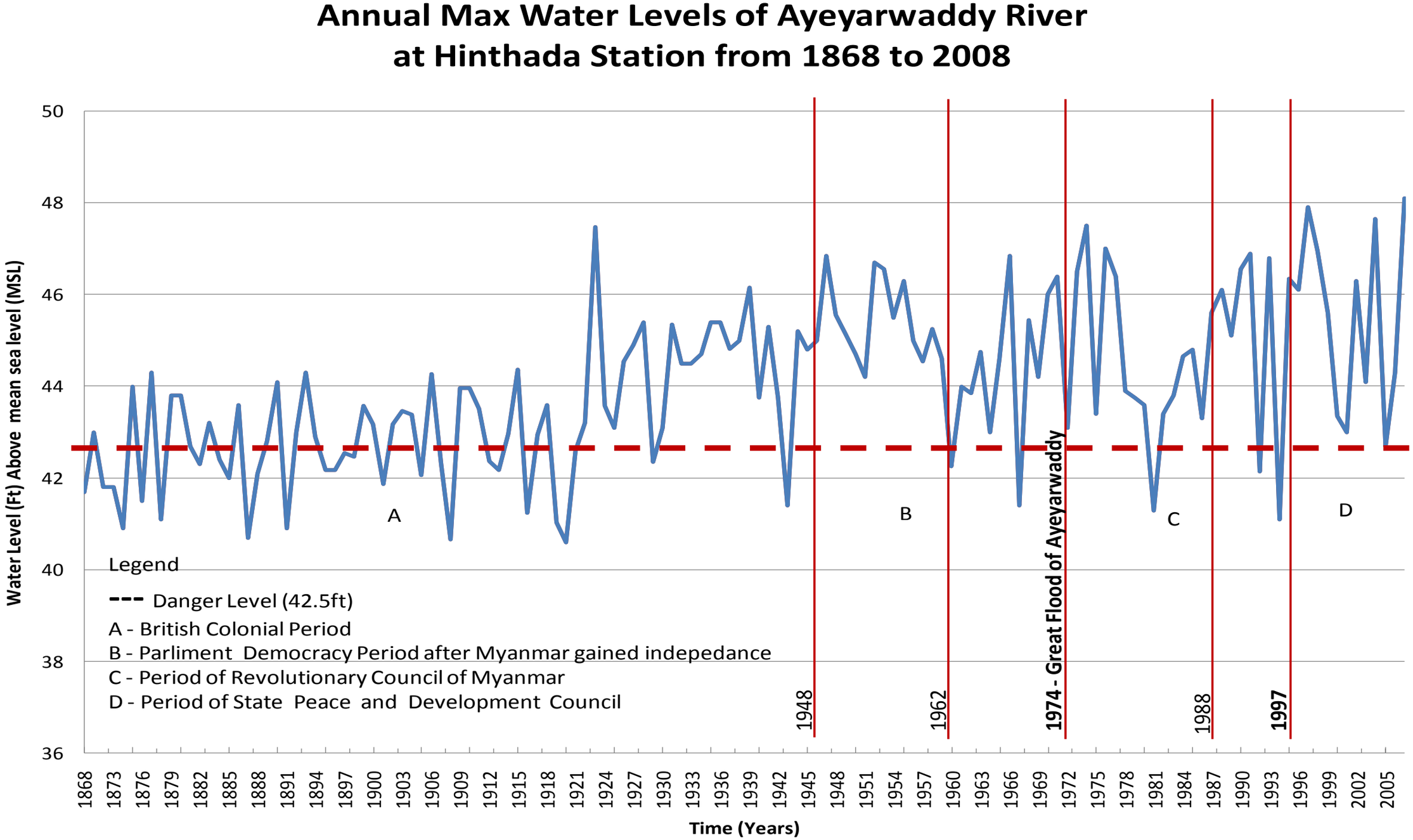
Paddy Land	Area (acres)	% by Delta Paddy Land Total	% by Total Protected Area	% by Flooded Area
Ayeyarwaddy Delta Total	***1,800,730***	***100%***		
Protected Area in 1974 Flood	***851,166***	***47%***	***100%***	
Flooded area in 1974	***278,339***	***15%***	***33%***	***100%***
Damaged Paddy land in 1974	***220,537***	***12%***	***26%***	***79%***

Influence of Tide Effect in Ayeyarwaddy Delta Along the Ayeyarwaddy River to The Sea during Great Flood of 1974



Cross Section of Ayeyarwaddy Delta Showing Fluctuation of Tide During Flood

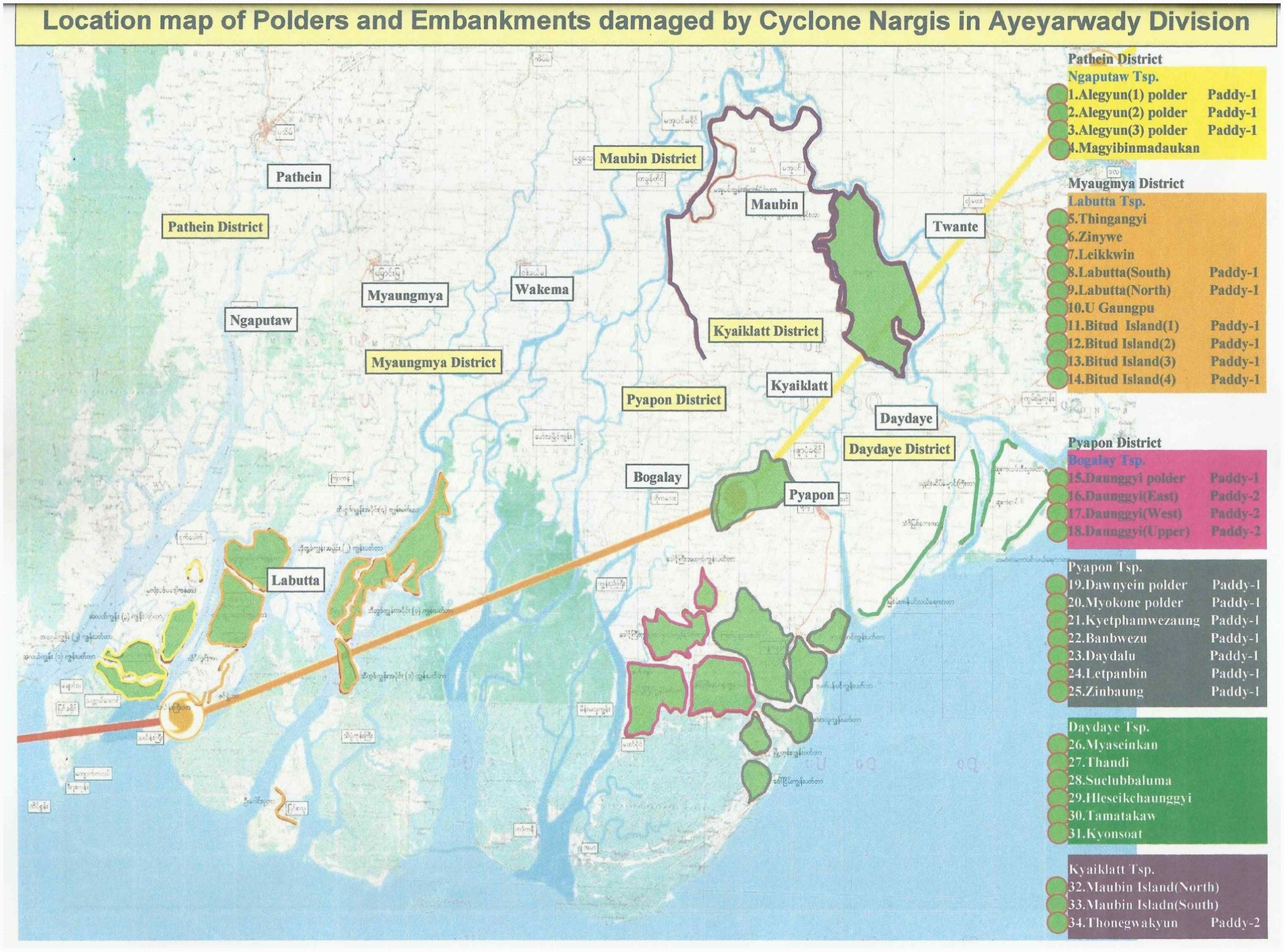
Annual Maximum Water Levels of Ayeyarwaddy River At Hinthada Station from 1868 to 2008



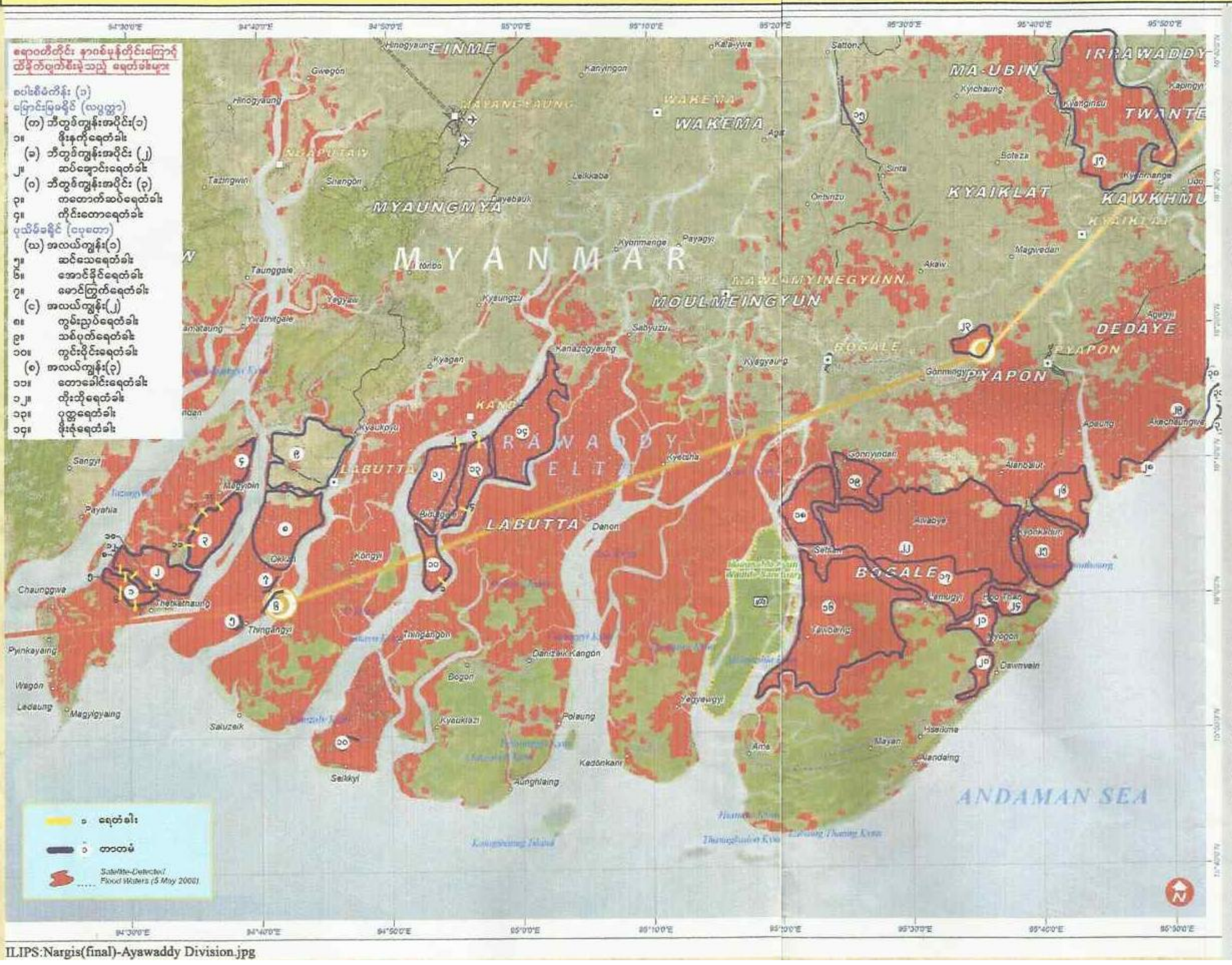
Natural Disasters in Ayeyarwaddy Delta : Storms Cyclone Nargis in 2008

- **On 2 May 2008,the delta suffered a major disaster ,developed by Cyclone**.
- The category 3 Cyclone Nargis Struck Myanmar on 2 and 3 May 2008,making landfall in the Ayeyarwaddy Division, approximately 250 km southwest of Yangon, and affecting more than 50 townships mainly in Yangon and Ayeyarwaddy Division, including Yangon, the country's largest city.
- With wind speed of up to 200 km/h accompanied by heavy rain, the damage was most severe in the Delta region, where the effects of the extreme winds were compounded by a 12 foot (3,6 meter) storm surge.
- Nargis was the worst natural disaster in the history of Myanmar, and the most devastating cyclone to strike Asia since 1991.

Location Map of Polders and Embankments Damaged by Cyclone Nargis in Ayeyarwaddy Division (2008)



Location map of Polders and Embankments damaged by Cyclone Nargis



ILIPS:Nargis(final)-Ayawaddy Division.jpg

Pathein District

Ngaputaw tsp.

1. Alegyun (1) polder	paddy project -1
2. Alegyun (2) polder	paddy project -1
3. Alegyun (3) polder	paddy project -1
4. Magybinmadaukkan	

Myaungmya District

Labutta tsp.

5. Thingangyi	
6. Zinywe	
7. Leikkwin	
8. Labutta (South) polder	paddy project - 2
9. Labutta (North) polder	paddy project - 2
10. U Gaungpu	
11. Bitut Island (1) polder	paddy project - 2
12. Bitut Island (2) polder	paddy project - 2
13. Bitut Island (3) polder	paddy project - 2
14. Bitut Island (4) polder	paddy project - 2

Phyapon District

Kyaiklat tsp.

15. Maubin Island polder	

Bogalay tsp.

16. Daukgyi Island polder	paddy project - 1
17. Daukgyi (East) polder	paddy project - 2
18. Daukgyi (West) polder	paddy project - 2
19. Daukgyi (Ahtet) polder	paddy project - 2
20. Daw Nyein polder	paddy project - 1
21. Myo Gone polder	paddy project - 1
22. Kyetphamwezaung	paddy project - 1
23. Banbwezu	paddy project - 1
24. Daedalu	paddy project - 1
25. Latpanbin	paddy project - 1
26. Zinbaung	paddy project - 1
27. Thonekhwa	paddy project - 2

Daedaye tsp.

28. Myaseinkan embankment	
29. Thandi embankment	
30. Sueclub Baluma embankment	
31. Hlesaik chaunggyi embankment	
32. Tamartakaw embankment	

Recent Flood In Myanmar ,2012 August

Flooded farmlands in Thapaung Township, of Ayeyarwaddy Region seen on 11 August

Flooded farmlands in Darka Township of Ayeyarwaddy Region seen on 16 August

Flooded farmlands in Bago Township seen on 17 August

Flooded farmlands in Taungoo seen on 13 August

Recent Flood in Myanmar, 2012 August
Facts and Figures

- Total areas flooded — 530,000 acres
- **Flooded. Areas by August 17** — **528,000 acres**
  - Flooded areas :
    - Lower Myanmar ,
      - in Ayeyarwaddy Delta — - Ayeyarwaddy, Bago, and Yangon Regions
      - in Coastal Strips — - Mon and Kayin States ,and Taninthintharyi region
    - Upper Myanmar ,
      - Hilly Area of Northern Shan
- **Damaged paddy field by flood** — **56,767. Acres**
  - Medium flooded areas that flood may be reduced. — 136,000. Acres
  - Still under flooded condition. — the remaining fields
- **Number of townships flooded** — **55 towns**
- **Duration of flood** — **15. to. 20 -30 days. Starting from end of July 2012**
- **Impact on Paddy Field**
  - Draught areas with no rain at all in Upper Myanmar — Dry Zone Sagaing, Mandalay, Magwe
  - Duration of tolerance for flooded paddy rice — 15 days
  - Possible damaged paddy field. — 119,000 acres
  - Reserved seeds to plant the flooded areas of 119,000 acres. — 387,633 baskets
  - required seed to plant. — 2 1/2. To. 3 baskets per acre
  - present possible seeds required — 80% of flooded 530,000 acres
  - Cost of seed to plant normal rice 4,500ks./ basket — Pawsan rice 7,000ks/ basket
  - Paddy Fields in Present flooded areas — 4.9 million acres
  - Submerged paddy field. — 0.53 million acres.
  - More than 11% of total paddy land affected
- **Flood in Bago areas of Bago,Thatnatpin,Waw,Kawa townships, in Lower Myanmar**
  - Flooded Areas started from 20 July and lasted for 20 days
  - Duration of Bago river Flood. also lasted for 20 days
  - Flooded paddylands are more than 10,000 acres
  - planned rained paddy in Bago area in 2012-13. — 116,089 acres
  - **paddy Areas already planted by 15August.** — **102,184 acres**
- **Flooded areas of planted paddy in Bago areas** — **11611 acres. (11% of the total planted areas)**

(Source:Eleven Media Group news on line on 19August2012)

Recent Flood In Myanmar , August,2012

Bago, City of Bago Region was seen flooded on 5 August 2012.

Ma Dauk Town in Bago Region, near Sittaung River in August

Pathein, The City of Irrawaddy Region was found on flood 10 August 2012

villages in Thaboung Township ,Irrawaddy Region ,flooded on 9 August

Recent Flood in Myanmar, 2012 August
Possible Causes, Effects and Recommended Measures

Possible Causes

1.Severe rainfall intensity and long duration of rainfall in the whole areas of lower Ayeyarwaddy delta region

2.Severe flood occurred between full moon day (2August2012) and new moon day(17 August2012) of which highest high tide level normally occured around these days so that sea tide intruded along rivers in lower Ayeyarwaddy delta and inundated the paddy fields during continuous heavy rain in the region.

3.Poor drainage channels in the paddy fields ,to drain out flooded water when nearby river flood receded

4.here was a lack of proper and effective control measures to prevent sea tide during heavy rain in the paddy fields of most of the Lower Ayeyarwaddy delta except some polders with proper drainage facilities of canals and sluice structures were built in some areas by Paddy 1 and 2 Projects financed by World Bank

5.Possible Climate change impact with abnormal rain fall pattern in the region together with certain sea level rising affects

Effects

1.Many Paddy fields were damaged by flood that leads to reduction of paddy rice production

2.Adverse impact on social and economic life of the people in the flooded region

Recommended Measures for action against flood in Ayeyarwaddy Delta

1.Provision of proper drainage facilities for the paddy fields in the Ayeyarwaddy Delta

2.Implementation of polder and reclamation Projects in integrated approach by taking into account the social, economic and environmental situation of the areas concerned.(Prospect of Paddy3 Project)

Conclusion

- **Challenges**
  - **Effective Integrated Management of Water Resources in River**
  - **Growing Population of Myanmar and the future Mega City, Yangon, adjacent to the delta**
  - **The formulation and design of different type of water resources development projects, it's impacts, consequences and future development prospects and potential of the Ayeywarwaddy Delta water management**

- **Recommendations**
  - **To locate the area for tidal gravity irrigation in strategic places in deltas as a blue water resources management**
  - **Formulation for the planning ,design and implementation of tidal hydraulic works for flood control, drainage and irrigation combined in tidal flat lands of Ayeyarwaddy delta of Myanmar can be applied in other similar deltas of the world for paddy production.**

References

- 1.Agricultural statistics 1985-86 to 2004-2005 , Central Statistical Organisation and Department of Agricultural Planning,Yangon,Myanmar
- 2.A Volker,(1983) Rivers of Southeast Asia,Symposium,Germany
- 3.Aye Myint ,(2011) Nyaungdone Island Reclamation Project SIWW presentation:,Singapore
- 4.Aye Myint ,(2011) WDS presentations in Jakarta
- 5.Kyaw Myint,1998,Agriculture by Ages ,history of paddy production ,MOAI
- 6.Myanmar Agriculture in Brief,2011,Department of Agricultural Planning,Ministry of Agriculture and Irrigation
- 7.Nicholas Odd,(1982) One Dimensional Analysis of the Tidal Hydraulics of Deltas.,HRS, ,U.K
- 8.Statistical Year Book,,2010,Ministry of Planning and Economic Development,Myanmar
- 9.Wen Jun ZHANG and GuoDao LIU, ChangJun BAI, A Forecast Analysis on Global Production of Staple Crops, Research Institute of Entomology, Sun Yat-sen (Zhongshan) University and Chinese Academy of Tropical Agricultural Sciences, Hainan, China,(web :15August2012)


Thank You
for Your Kind Attention