

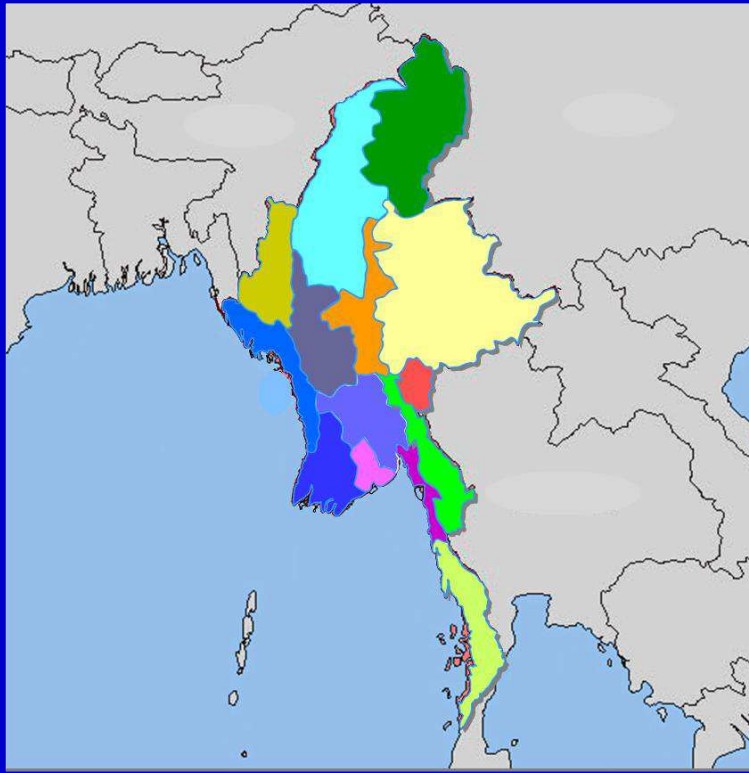


Climate Change Adaptation and Water Nexus in Myanmar

Department of Meteorology and Hydrology, MYANMAR

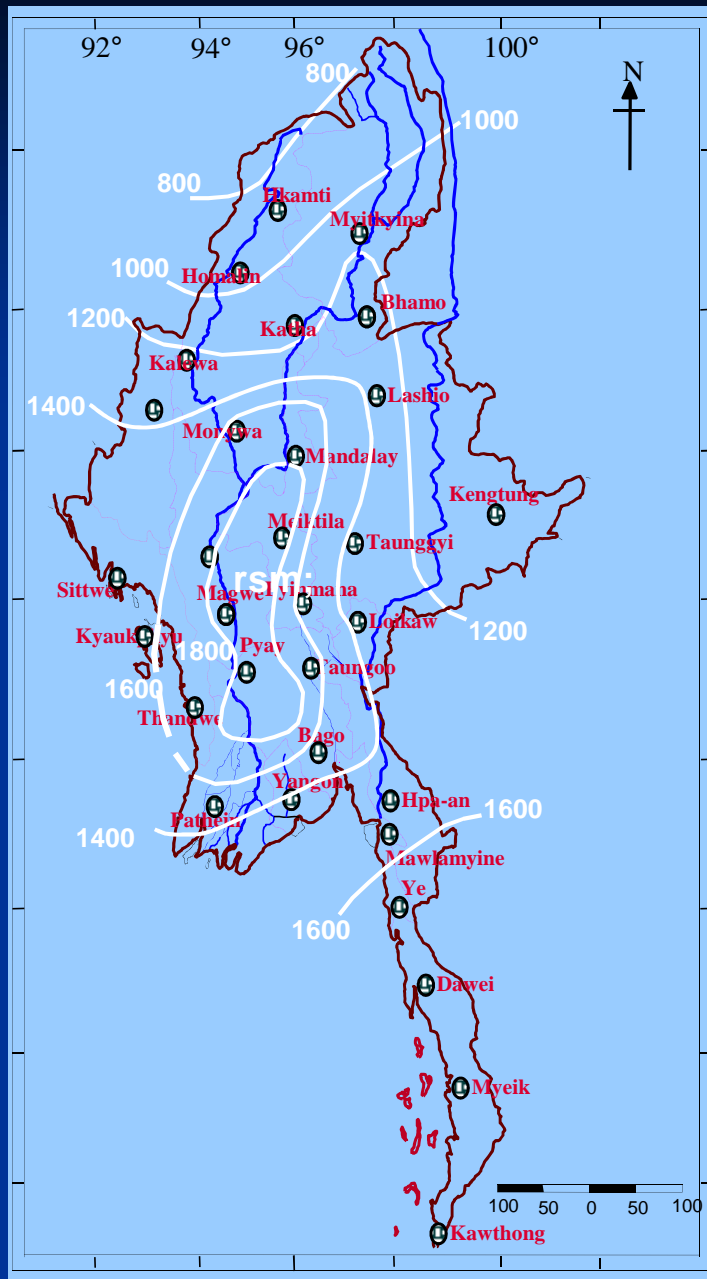
Nay Pyi Taw, Myanmar.

MYANMAR

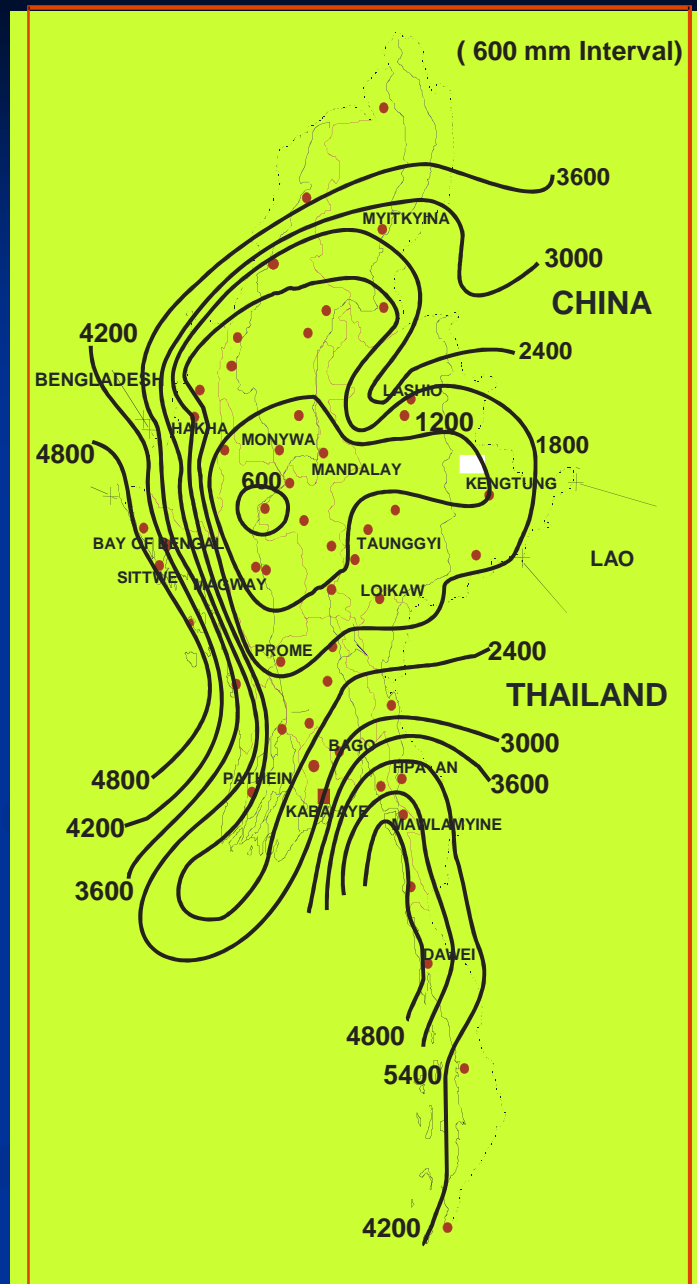


- *Location:* lat: 9° 28' & 28° 31' N
long:: 92° 10' & 101° 11' E
- *Area:* 687,033 sq km
- *Neighbouring countries :*
 - (1) N & NNE : China
 - (2) E & SE : Lao , Thailand
 - (3) S : Andaman sea & Bay of Bengal
 - (4) W : Bangladesh & India
- *Coastal seashore :* 2,276 km
- *Four distinct physical units:*
 - (1) The western mountain ranges
 - (2) The Shan plateau
 - (3) The central basin
 - (4) Rakhine coast strip
- *Four major river systems:*
 - (1) Ayeyarwady
 - (2) Chindwin
 - (3) Sittaung
 - (4) Thanlwin

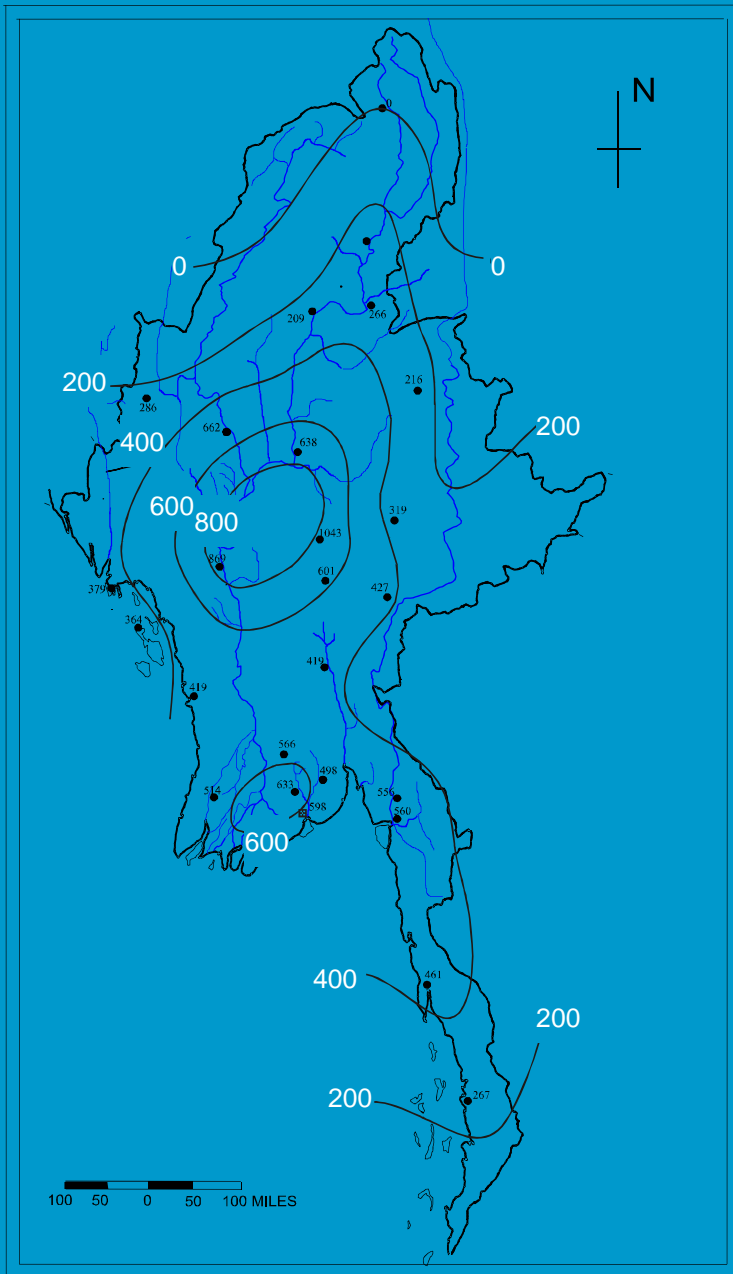
Mean Annual Evaporation (mm)



Mean Annual Rainfall (mm)



Total Soil Water Deficit



Seasonal rainfall distribution in
% of annual

Area (Annual rainfall- mm)	Mar- Apr Hot Season	May-Sep Monsoon	Oct- Nov Post monsoon	Dec- Feb Cool wx
N & NW (2600)	7	80	10	3
West (4000)	10	72	15	3
East (1200)	8	60	20	12
Central (800)	5	70	20	5
Delta (2700)	2	85	10	3
South (4000)	6	78	10	6

CLIMATE OF MYANMAR

Three seasons

(1) Summer season (*March to May*)

(2) Rainy season (*June to October*)

(3) Winter season (*November to February*)

Annual Rainfall

Central Myanmar : 1016 mm (40 in)

Coastal Region : 5000 mm (200 in)

Mean Maximum Temperature

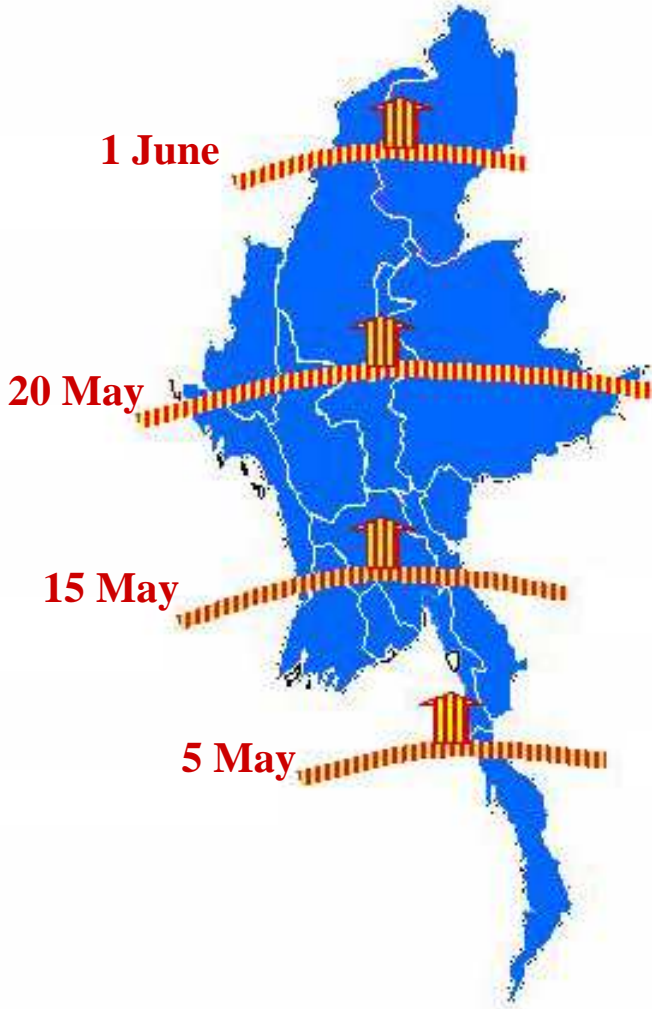
Central Myanmar : 40 °C (104 °F)
[March & April]

Mean Minimum Temperature

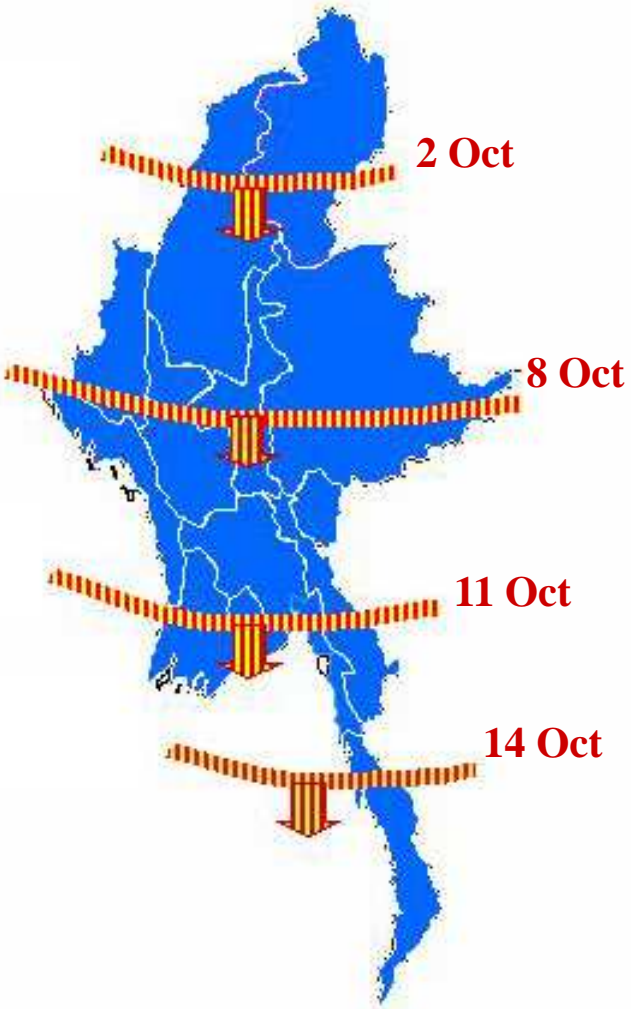
Northern Myanmar : 0 °C-10 °C (32 °F - 50 °F)
[Jan & Feb]

SOUTHWEST MONSOON

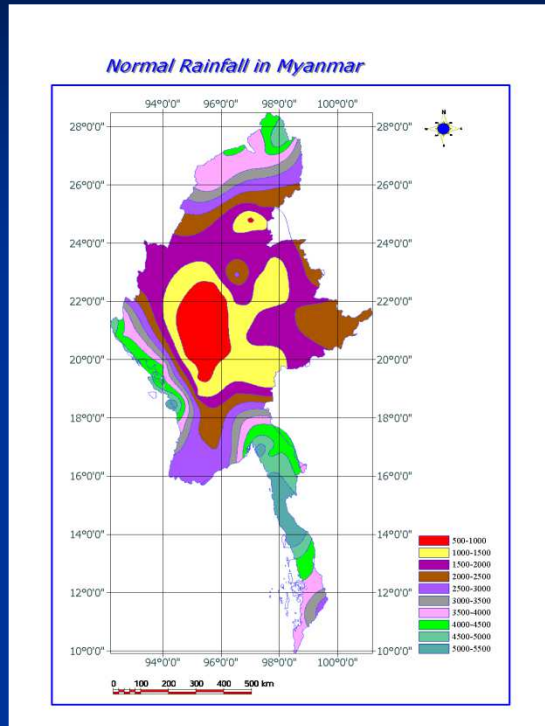
Normal Onset Date



Normal Withdrawal Date



Annual Rainfall in Myanmar



	Region	Rainfall (mm)	Remarks
1	<u>The western slopes</u> of the Chin and Rakhine Hills and the Taninthayi Ranges	3500 to 5000	
2	Chin Hills	2500 to 3500	
3	Northern Hills	2000 to 3500	
4	Central Myanmar (Rain shadow area of Chin and Rakhine Hills)	600 to 1000	Dry Zone
5	Shan Highland	1500 to 2000	East of Dry Zone
6	Deltaic Plains	2000 to 2500	South-western Part of Myanmar

Normal Annual Rainfall(mm) in Myanmar

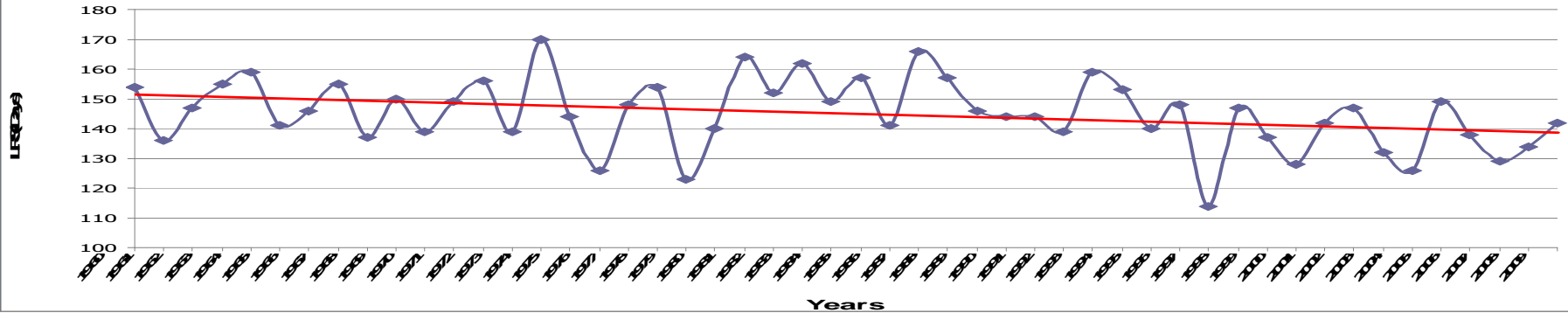
State/Region station	Annual rainfall (mm)	State/Region station	Annual rainfall (mm)
<u>KACHIN</u>	2 633	Homalin	2 187
Putao	4 036	Katha	1 562
Myitkyina	2 099	Pinlebu	1 393
Bhamo	1 763	Mawlaik	1 657
		Kalewa	1 659
<u>SHAN</u>	1 474	Kalemyo	1 513
Hsipaw	1 231	Mingin	1 369
Lashio	1 377		
Taunggyi	1 510	<u>LOWER SAGAI</u>	828
Kengtung	1 269	Shwebo	867
Loilem	1 448	Monywa	789
Pinlaung	2 008		
		<u>MANDALAY</u>	945
<u>CHIN</u>	2 233	Pyinoolwin	1 595
Falam	1 542	Mandalay	714
Mindat	1 648	Meiktila	857
Paletwa	3 508	My ingyau	657
		Nyang U	611
<u>UPPER SAGAING</u>	1 880	Yamethin	822
Hkamti	3 699	Pyinmana	1 362

Normal Annual Rainfall(mm) in Myanmar

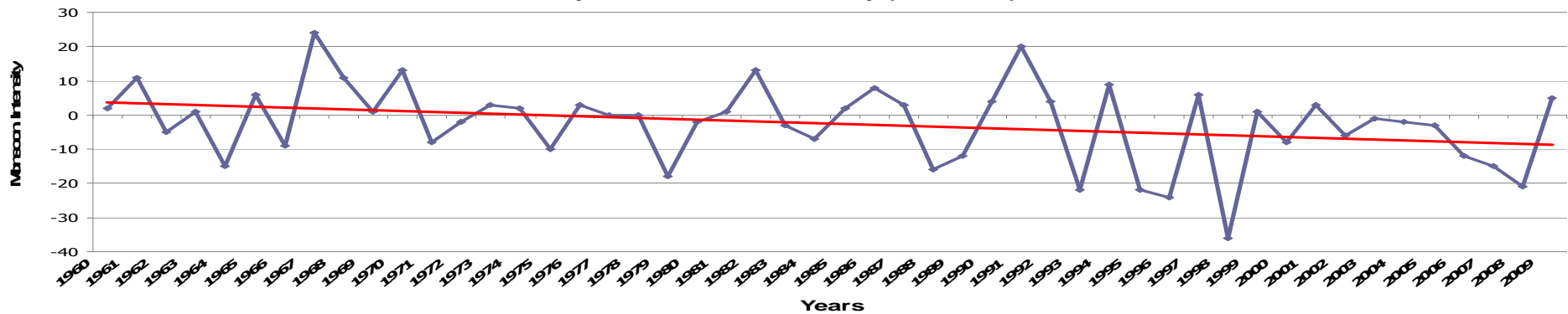
State/Region station	Annual rainfall (mm)	State/Region station	Annual rainfall (mm)
<u>AYEYARWADY</u>	2 536	<u>BAGO</u>	2 395
Henzada	2 263	Prome	1 312
Maubin	2 409	Toungoo	2 010
Patheingyi	2 935	Tharrawaddy	2 164
<u>KAYAH</u>	1 254	Shwegyin	3 167
Loikaw	1 254	Bago	3 320
<u>KAYIN</u>	3 454	<u>YANGON</u>	2 550
Hpa-an	4 314	Hmawbi	2 517
Papun	2 594	Mingaladon	2 526
<u>MAGWAY</u>	1 362	Kaba-Aye	2 606
Pokokku	680	<u>MON</u>	4 089
Chauk	905	Bilin	5 203
Minbu	1 102	Thaton	5 393
Gangaw	1 314	Mawlamyine	4 754
<u>RAKHINE</u>	4 958	Ye	5 007
Sittwe	4 710	<u>TANINTHARYI</u>	4 318
Kyaukpadaung	4 708	Dawei	5 360
Sandoway	4 457	Mergui	3 932
		Kawthoung	3 852

Sample Climate trend of Myanmar(1960-2009)

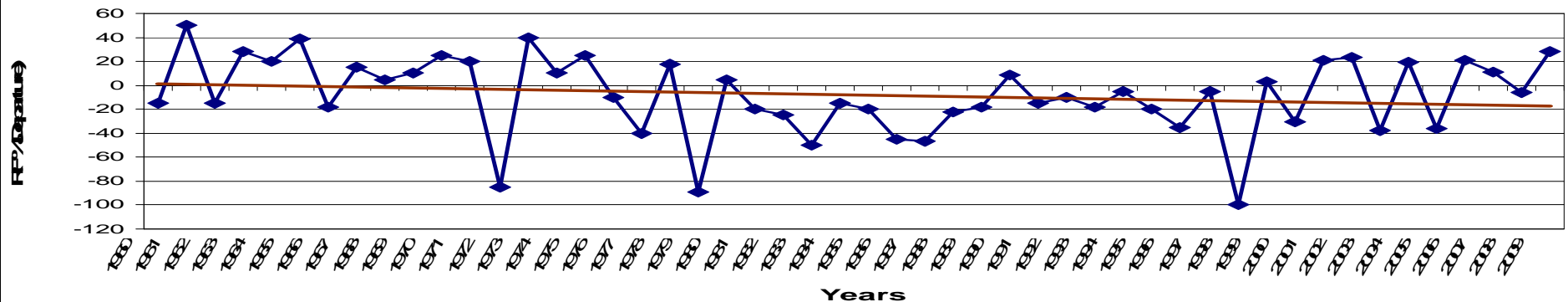
Lenght of Rainy Season(Days) of Myanmar (1960-2009)



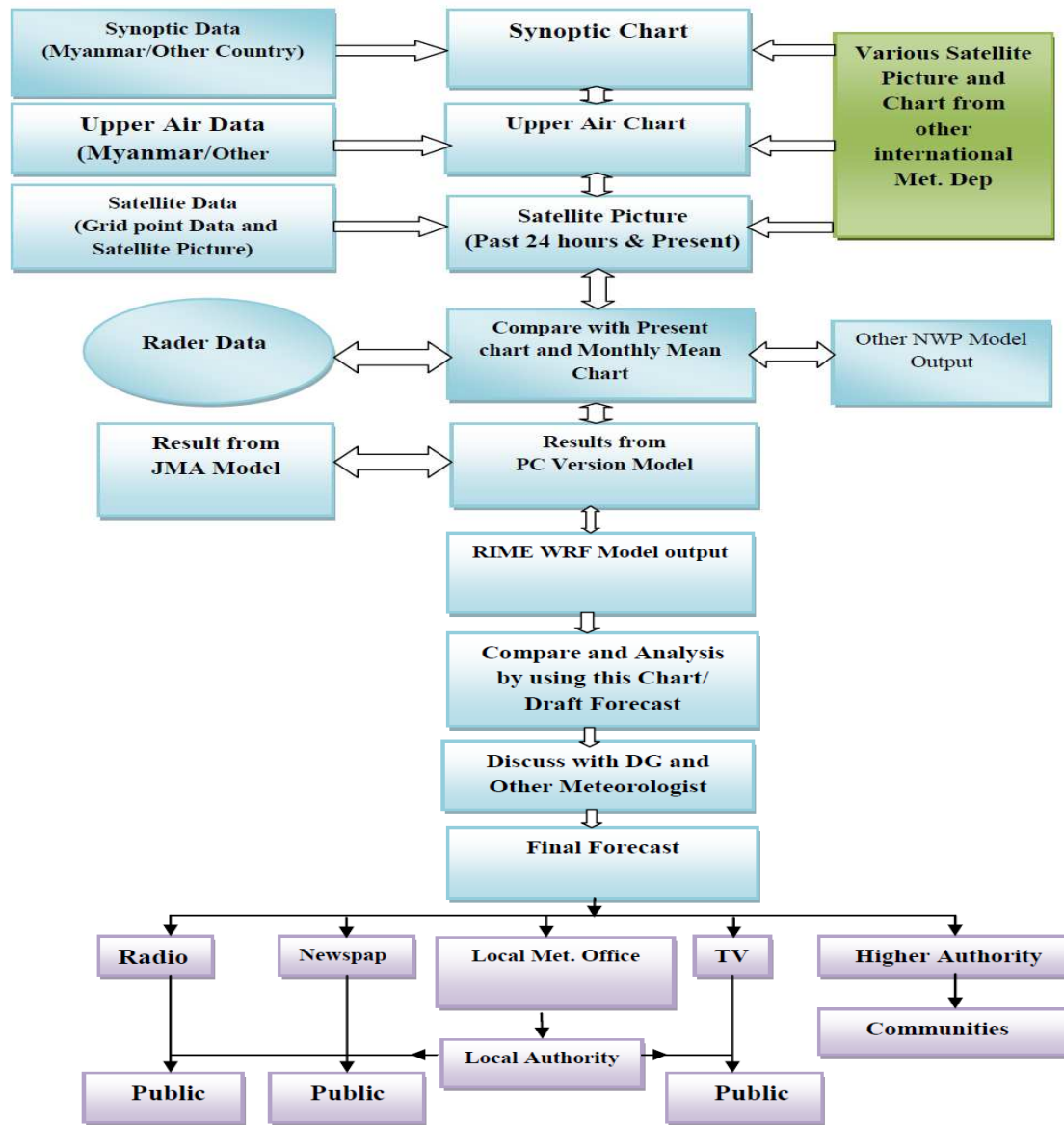
Myanmar Monsoon Intensity (1960-2009)



Myanmar Monsoon Rainfall % Departure (1960-2009)



**Daily Weather Forecast
Issuing Step and Dissemination System**



2010/2011 Myanmar Extreme Climate...

- Extreme Temperature
- 47.2 °C (Maximum Temperature)
- Myinmu(Dry zone)
- 14 May 2010
- El Nino (Drought)
- Extreme Rainfall
- 29.10 Inches/12Hr
- Taungkok(Coastal)
- (21 July 2011)
- Anti El Nino (Flood)



Different types of
Impacts on huge
Socio-Economic
Value and
Different Areas

Agriculture



Rainfall Variability...

- Intensity of Summer Monsoon wind.
- Frequency of Tropical Cyclone & Monsoon Depressions.
- Active & Break Cycle of Monsoon.
- (2) Cyclone Seasons on Apr/May & Oct/Nov.
- Movement and Frequency of Disturbances.
- Regional scale Climate Impacts (El Nino/La Nina).

Temperature Changes...

- Intensity of Summer/Winter Monsoon wind/Source.
- Regional Warm/Cold Air Surge of Monsoon.
- Movement and Frequency of Disturbances.
- Regional scale Climate (El Nino/La Nina).

Related International Organizations for Climate Change

- *World Meteorological Organization (WMO)*
- *United Nations Environmental Programme (UNEP)*
- *Intergovernmental Panel on Climate Change (IPCC)*
- *United Nations Framework Convention on Climate Change (UNFCCC)*
- *World Weather Watch (WWW)*
- *Global Climate Observing System (GCOS)*
- *Panel on Tropical Cyclone (PTC)*
- *National Meteorological & Hydrological Services (NMHSs)*

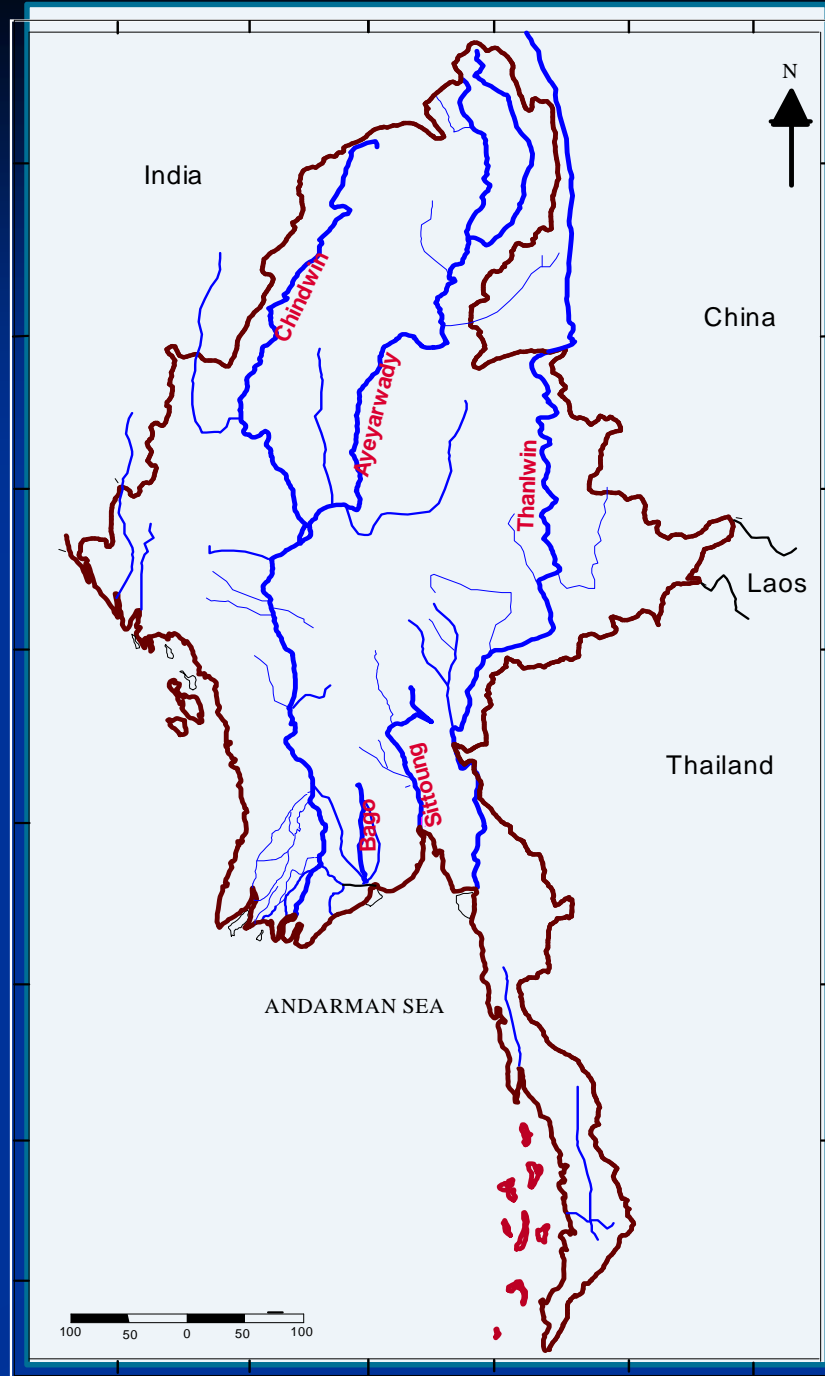
Activities for Climate Change

- *Observing Meteorological & Hydrological data*
- *Analyzing data*
- *Monitoring the changes of climate condition*
- *Cooperating with related organizations*
- *Researching climate phenomena*
- *Issuing Global and Local Climate Change*
- *Organizing the International & Local seminars, meetings, workshops*

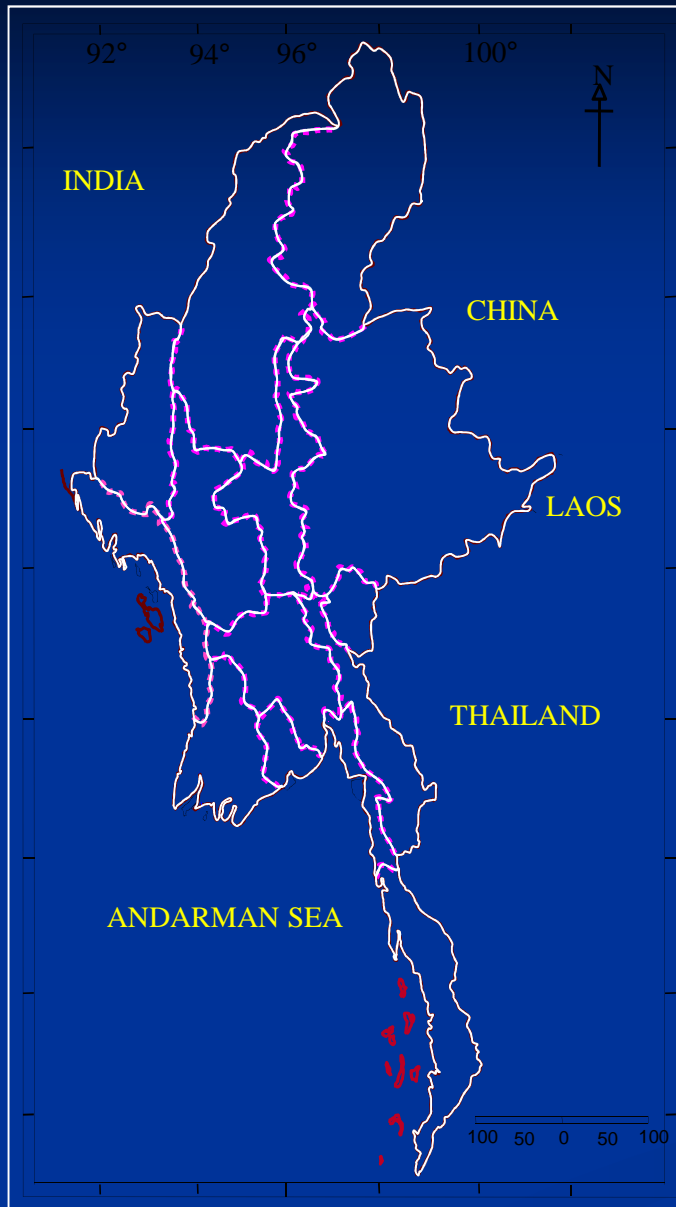
Climate Change and Myanmar

- *Monsoon Depressions form in Bay of Bengal more than last two decades*
- *Storm tracks become to change from normal*
- *More occurrence of severe Storms*
- *Temperature, Precipitation and Sea level rise along Myanmar coast are not indicate clearly change*
- *National Environmental Activities protect changing climate*

Rivers in Myanmar



Observation Stations



<i>Meteorological Station</i>	-	<i>63</i>
<i>Hydrological station</i>	-	<i>30</i>
<i>Met & Hydro station</i>	-	<i>39</i>
<i>Agro-Met Stations</i>	-	<i>18</i>
<i>Aviation-Met station</i>	-	<i>8</i>
<i>Seismological station</i>	-	<i>11</i>

Strategies and Options for Flood Management

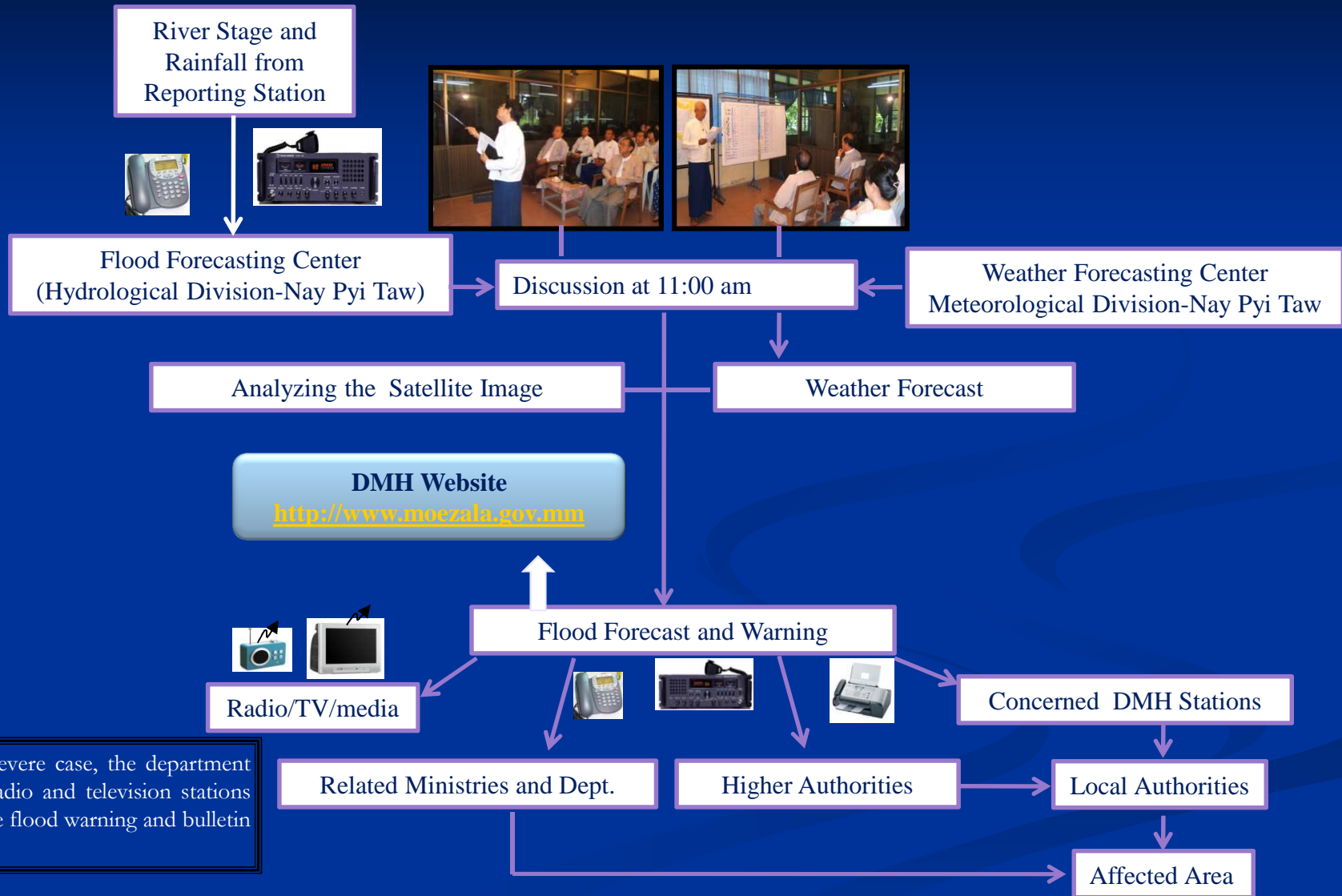
Reducing Flooding → Dams and reservoirs
Dikes, levees, and flood embankments
High flow diversions
Catchment managements

Reduction susceptibility of damage → Flood plain regulation
Development and redevelopment policies
Design and location of facilities
Housing and building codes, Flood-proofing
Flood forecasting and warning

Mitigating the impacts of flooding → Information and education
Disaster preparedness
Post flood recovery, Flood insurance

Preserving the natural resources → Flood plain zoning and regulation of Flood Plains

Flood Forecasting and Warning System



If the flood is severe case, the department has to request radio and television stations to broadcast the flood warning and bulletin frequently

Action taken during the Severe Flood

- Sending Hydrologist to the affected area
- Taking hourly water level data
- Taking part in flood Committee of affected township

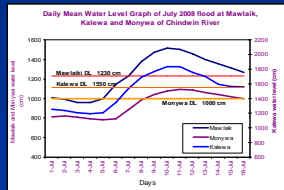
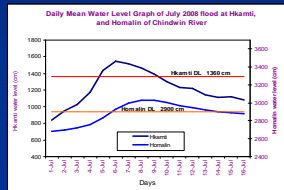
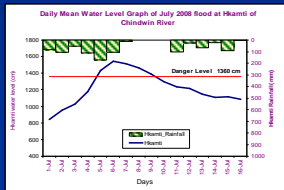
Flood Survey

- Collecting data of inundated area and flood marks
- Collecting data of damages caused by the flood
- Meeting with township authorities to get information
- Submitting Flood Survey report
- Flood Plain Mapping



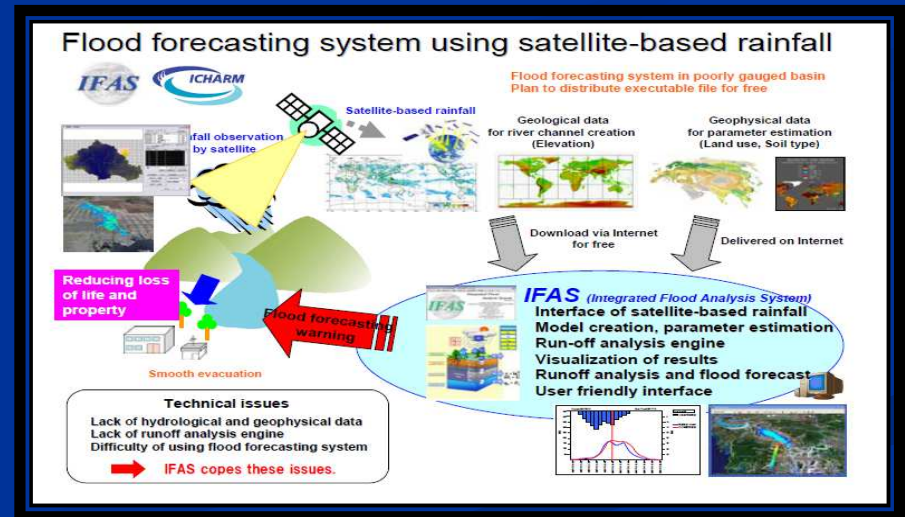
Current Flood Warning System

- Using river stage correlation between upstream station and downstream station, and empirical Model for flood forecast and early warning



Future Plan

- the modernized flood forecasting technique and advanced flood forecasting models will be applied



Thank you for your kind attention!