MYANMAR

Source: esri

General

Myanmar - officially the Republic of the Union of Myanmar, also known as Burma - is a sovereign state in Southeast Asia, bordered by India and Bangladesh in the West, Thailand and Laos in the East and China in the North and Northeast. In the South, about one third of Myanmar's total area forms an uninterrupted coastline of 1,930 km along the Bay of Bengal and the Andaman Sea. The area of Myanmar is 67.7 Mha (million hectares) with, in 2022, a population of 54.2 million, or 0.8 persons per ha (Wikipedia and United Nations, 2022).

Climate and geography

Much of the country lies between the Tropic of Cancer and the Equator in the monsoon region of Asia. The coastal regions receive over 5,000 mm of rain annually. Annual rainfall in the delta region is approximately 2,500 mm, while average annual rainfall in Central Myanmar is less than 1,000 mm. The Japan International Cooperation Agency (JICA) *et al*. (2011) present a Table with the chance of occurrence of extreme rainfall for Rangoon and Pathein (Table I).

Table I. Chance of occurrence of extreme rainfall in mm for the stations Rangoon and Pathein (Japan International Cooperation Agency (JICA) *et al*., 2011)

Station	Rangoon			Pathein		
Chance of occurrence per year in %	One day maximum	2 day consecutive	3 day consecutive	One day maximum	2 day consecutive	3 day consecutive
20	147	204	236	161	242	308
10	170	234	267	183	278	353
5	192	263	296	205	312	395
4	199	272	305	212	323	408
2	220	300	334	232	357	450
1	241	328	363	253	390	491
0.5	262	356	391	274	424	532

The Northern regions are the coolest, with average temperatures of 21 °C. Coastal and delta regions have an average maximum temperature of 32 °C.

Myanmar is frequently hit by cyclones. Some characteristic data are shown in Table II.

Table II. Historical cyclones that hit Myanmar
(Japan International Cooperation Agency (JICA) *et al*., 2011)

Cyclone	Date of occurrence	Death*)**)	Affected*)
-	19 May 1926	2700	Unknown
Cyclone 196510	23 October 1965	100	500,000
Cyclone 196702	16 May 1967	100	130,200
Cyclone 196712	23 October 1967	178	Unknown
Cyclone 196801	10 May 1968	1070	90,000
Cyclone Nargis	2 May 2008	133,000	1,200,000-1,900,000

*) Government of Myanmar, **) Includes missing people

The Group Polder Development (1982), and Centre for Civil Engineering Research and Codes (CUR) and Ministry of Transport, Public Works and Water management (1993) describe that until 1850 most of the Irrawaddy Delta - about 3.5 Mha - was in its natural state. Following the rush of the settlers from Upper to Lower Myanmar, the construction of dikes to protect the areas from being flooded kept pace with the increase in population. The system of dikes provides a unique example of partial flood protection. The major dikes form a horseshoe around the areas between the river distributaries, leaving the downstream ends open (Figure 1). In the coastal zone a modest start was made to build sea dikes to

protect the lands from being flooded with saline water.

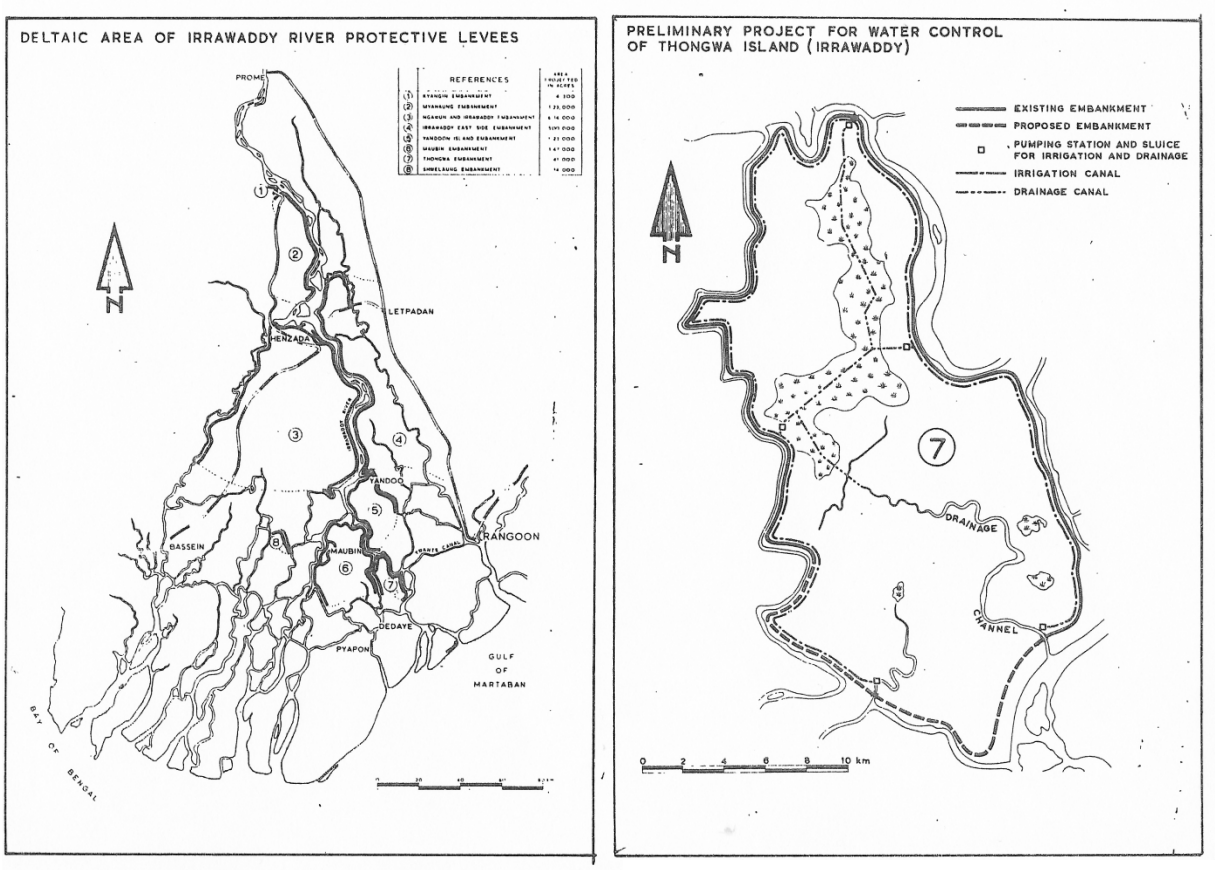


Figure 1. Flood protection in the Irrawaddy Delta (Group Polder Development, 1982)

The Japan International Cooperation Agency (JICA) *et al*. (2011) describe that dike building in the Irrawaddy Delta started in 1861 and that many dikes were constructed between 1880 and 1920. In 1909 the Burma Embankment Act was enacted and the Manual on Care and Maintenance of Embankments was released. By 2011 600,000 ha of rice fields were protected at a risk of failure of 5% per year.

The Japan International Cooperation Agency (JICA) *et al*. (2011) also describe that the Irrawaddy Delta is the major rice producing area in Myanmar. Due to the cyclone Nargis in 2008 there were 140,000 casualties and 770,000 ha rice field was damaged (Figure 2). The damage was caused by flooding and salt water intrusion and seriously affected the living conditions in the polders.

The Netherlands Embassy in Bangkok and Netherlands Economic Mission in Rangoon (2015) state that one of the regional challenges are the modernization of agricultural polders.

JICA *et al*. (2011) describe that in the polders in the Irrawaddy Delta there is no need to store abundant rainwater during the rainy season. The old river courses are functioning as major drains and small artificial drains are connected with the dikes as required in the areas. Whereas in the areas surrounded by dikes, man-made drains are predominant. In the final stage of the rainy season the slide gates of the sluices located at the outlets of the drains are closed to store the fresh rainwater in the drains. Salt water intrusion through degraded slide gates and flap gates may occur. Hence, the water impounded in the drains will then be contaminated with salty water.

The capacities of the drainage network are usually determined to drain 5 days consecutive rainfall at 5 years return period within 10 days. At the peak of the rainy season, inundations of the paddy fields sometimes occurs in low-lying areas or in areas with insufficient drainage capacity. The drainage condition of areas with an insufficient drainage network would be improved by providing additional facilities. However, improvement of a drainage network in low-lying areas may not be possible by just improving gravity drainage. In such cases drainage by pumping becomes required. However, under the local conditions of Myanmar drainage by pumping is generally not feasible.

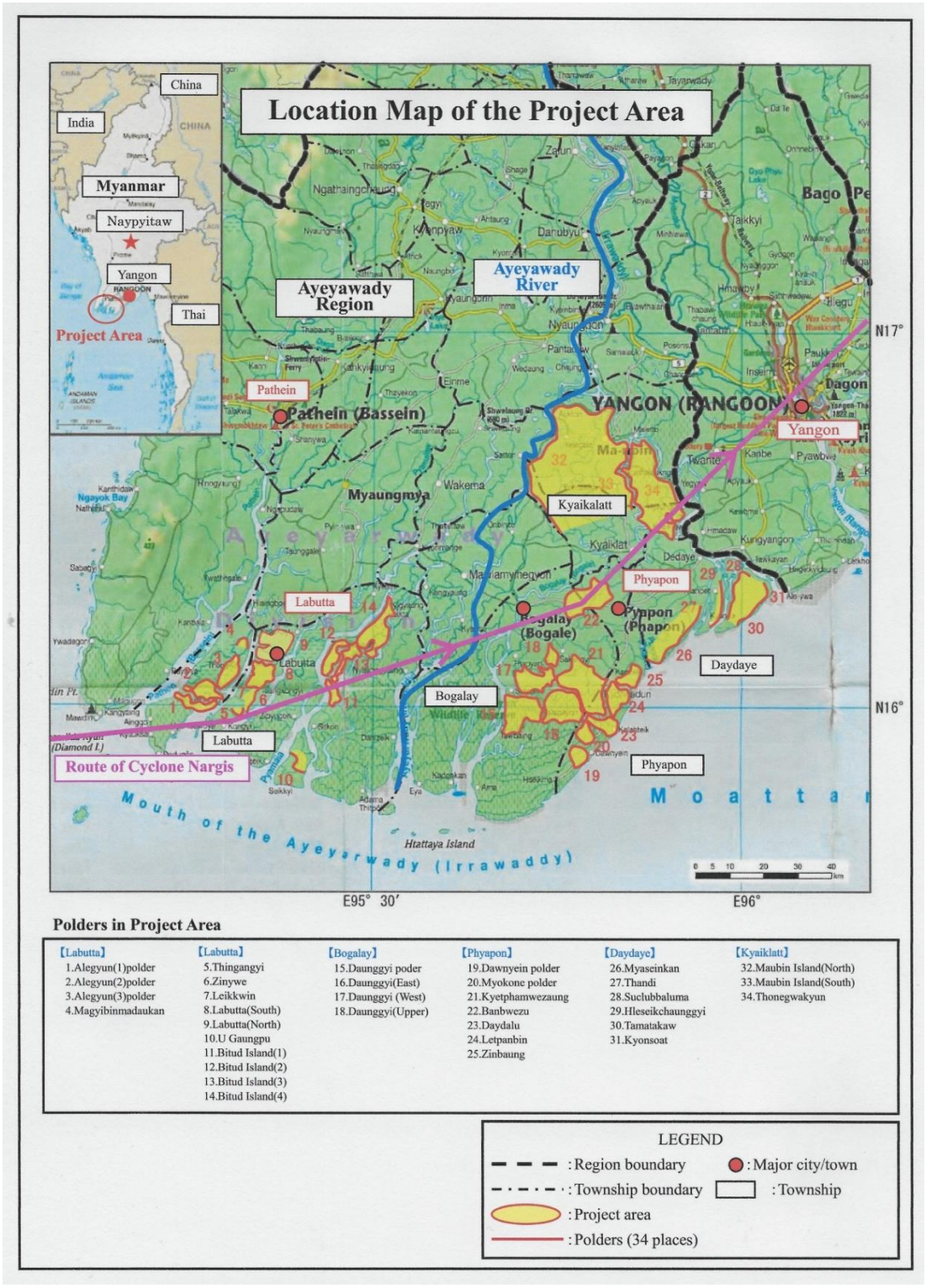


Figure 2. Location map of polders and dikes damaged by the cyclone Nargis (Zaw and Tant, 2010 and Japan International Cooperation Agency (JICA) et al., 2011)

JICA *et al*. (2011) also present a schematic cross-section and layout of the drainage systems (Figure 3). The characteristic data are: top width 3.0 - 105.0 m, bottom width 1.2 - 45.0 m and depth 0.45 - 5.4 m. The length of the drains varies from 48 m to 20.9 km. The average density of the drains was determined at 0.83 km/km^2.

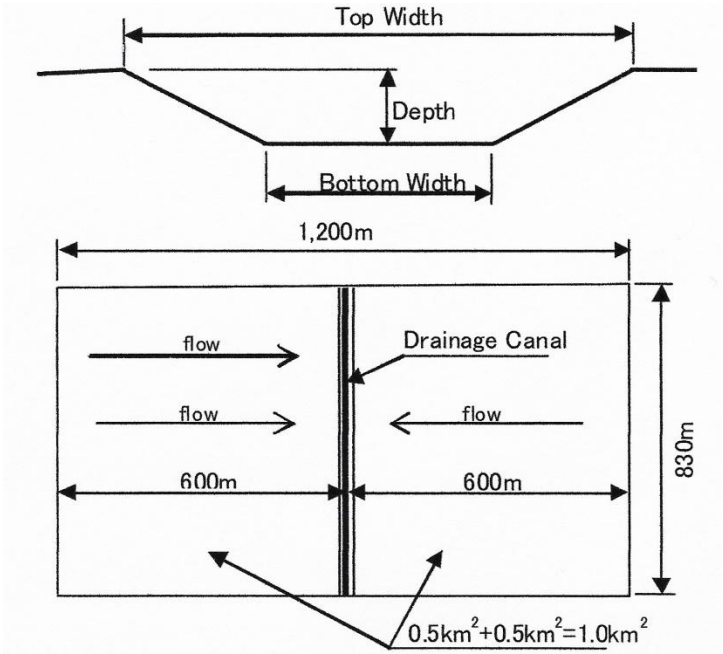


Figure 3. Schematic cross-section and lay out of the drainage systems in the Irrawaddy Delta (JICA et al., 2011)

In systems with gravity drainage the water level in the drains fluctuates according to the discharge of excess rainfall, river water levels and operation of the gates. During the wet season, rainwater accumulates inside the polders. When possible excess water is drained to the adjacent river through sluice gates. During the dry season, canal water levels inside the polders generally become lower than the river water level. In the coastal zone these levels may be influenced by the tidal fluctuation. When salinity problems can occur sluice gates have to be operated in such a way that salty river water cannot enter into a polder. Therefore, two types of gates exist in the sluices, flap gates at the river side to prevent river water from flowing into the polder, and at the polder side slide gates to control the storage of fresh water and to drain excess water when required (Figure 4). For example, the gates in the polders in the Ayeyawady Delta are operated by a simple operation rule. That is *open the slide gates on 15th May and close the slide gates in the last half month of September*. The flap gates are generally operated arbitrarily by difference in water level without manual control.

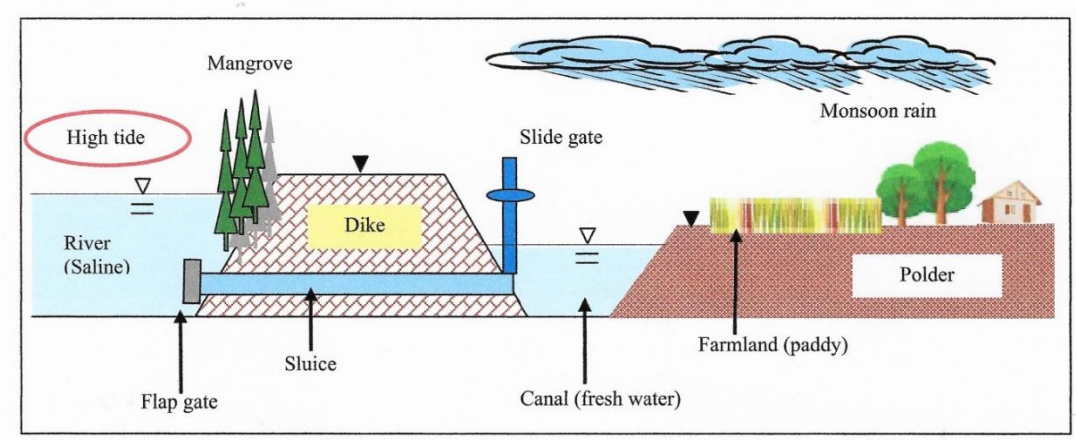


Figure 4. Schematic cross-section of a polder dike with a discharge sluice (JICA et al., 2011)

Existing polders

The Group Polder Development (1982) describes that in the Irrawaddy Delta an area of 626,520 ha has been endiked as described above.

Zaw and Than (2010) and JICA *et al*. (2011) present that 34 polders were damaged due to the Cyclone Nargis (Figure 2 and Tables I and II).

Rangoon reclamation Scheme (6,000 ha). This area has been reclaimed for urban and industrial development. The concerned areas are situated along the banks of tidal rivers surrounding the city of Rangoon. Drainage is provided by a drainage system that discharges through automatic sluices or pumping stations (Group Polder Development, 1982).

General characteristics of the polder in Myanmar are shown in Table III.

Proposed polders

No proposed polders have been identified.

Location of the polders in Myanmar as shown on the World polder map

The location of the polders in Myanmar is shown in Figure 5.

Figure 5. Location of the polders in Myanmar (source: esri – Batavialand)

The pictures by Prof. Adriaan Volker are shown in Table IV.

References

Centre for Civil Engineering Research and Codes (CUR) and Ministry of Transport, Public Works and Water management, 1993. *Hydrology and water management of deltaic areas*. CUR report 93-5. Gouda, the Netherlands

Group Polder Development, Department of Civil Engineering, Delft University of Technology, 1982. *Polders of the World, Compendium of polder projects*. Delft, the Netherlands

Horst, T. van der, M.M. Rutten, N.C. van de Giesen and R.F. Hanssen, 2018. Monitoring land subsidence in Yangon, Myanmar using Sentinel-1 persistent scatterer interferometry and assessment of driving mechanisms. *Remote Sensing of Environment*. 217, 101-110.

Japan International Cooperation Agency (JICA), Sanyu Consultants Inc. and Nippon Koei Co., Ltd., 2011. *The project for preservation of farming area for urgent rehabilitation of agricultural production and rural life in areas affected by cyclone Nargis in the Republik of the Union of Myanmar*. Ministry of Agriculture and Irrigation, The Republic of the Union of Myanmar.

Ministry of Agriculture, Livestock and Irrigation and Water Utilization Management Department. 2016. *Outline of irrigation and Water Utilization Department*.

Netherlands Embassy in Bangkok and Netherlands Economic Mission in Yangonon, 2015. *Factsheet water in Myanmar.*

United Nations, Department of Economic and Social Affairs, Population Division. 2022. *World Population Prospects, medium prognosis. The 2022 revision*. New York, USA.

Zaw, Tint and Mu Mu Than, 2010. *Climate change impacts to the water environment and adaptation options*. Union of Myanmar, Ministry of Agriculture and Irrigation, Irrigation Department. Powerpoint presentation.

Bart Schultz

Lelystad, October 2023

Table III. General characteristics of existing polders in Myanmar

Name	Reclamation	Area in ha	Type *)	Latitudes	Longitudes	Elevation in m+MSL	Land use
Polders in the Irrawaddy Delta							Mainly rice
* Alegyun (1) Polder		1,670	RLL	16º 01' N	94º 30' E	4	
* Alegyun (2) Polder		3,610	RLL	16º 02' N	94º 32' E	5	
* Alegyun (3) Polder		3,650	RLL	16º 05' N	94º 36' E	4	
* Magyibinmadaukan		550	RLL	16º 10' N	94º 38' E	6	
* Thingangyi		700	RLL	15º 58' N	94º 38' E	4	
* Zinywe		620	RLL	16º 01' N	94º 41' E	4	
* Leikkwin		380	RLL	16º 02' N	94º 39' E	4	
* Labutta (South)		2,870	RLL	16º 08' N	94º 42' E	5	
* Labutta (North)		7,830	RLL	16º 11' N	94º 44' E	6	
* U Gaungpu		370	RLL	15º 51' N	94º 48' E	6	
* Bitud Island (1)		1,900	RLL	16º 03' N	94º 53' E	5	
* Bitud Island (2)		2,780	RLL	16º 10' N	94º 54' E	5	
* Bitud Island (3)		3,220	RLL	16º 10' N	95º 00' E	4	
* Bitud Island(4)		7,640	RLL	16º 18' N	95º 04' E	5	
* Daunggyi polder		9,890	RLL	16º 00' N	95º 23' E	5	
* Daunggyi (East)		8,930	RLL	16º 03' N	95º 32' E	4	
* Daunggyi (West)		6,940	RLL	16º 05' N	95º 26' E	3	
* Daunggyi (Upper)		1,380	RLL	16º 09' N	95º 30' E	4	
* Dawnvein Polder		1,200	RLL	15º 54' N	95º 36' E	3	
* Myokone Polder		2,280	RLL	15º 58' N	95º 35' E	2	
* Kyetphamwezaung		12,570	RLL	16º 04' N	95º 36' E	3	
* Banbwezu		5,330	RLL	16º 16' N	95º 35' E	3	
* Daydalu		1,720	RLL	16º 00' N	94º 39' E	3	
* Letpanbin		3,460	RLL	16º 04' N	94º 40' E	3	
* Zinbaung		2,670	RLL	16º 06' N	95º 42' E	4	
* Myaseinkan		5,470	RLL	16º 14' N	95º 51' E	4	
* Thandi		1,390	RLL	16º 18' N	95º 53' E	4	
* Suclubbaluma		2,950	RLL	16º 23' N	95º 58' E	5	
* Hleseikchaunggyi		910	RLL	16º 23' N	94º 54' E	5	
* Tamatakaw		5,350	RLL	16º 17' N	96º 02' E	4	
* Kyonsoat		240	RLL	16º 20' N	96º 04' E	3	
* Maubin Island (North)		11,000	RLL	16º 49' N	95º 55' E	6	

* Maubin Island (South)		4,610	RLL	16º 47' N	96º 00' E	4	
* Thonegwakyun		8,120	RLL	16º 47' N	96º 05' E	4	
Remaining polders in the Irrawaddy Delta		486,320	RLL				
Rangoon Reclamation Scheme		6,000	RLL	16º 50' N	96º 16' E	4	Urban and industry
Total		626,520					

*) RLL = reclaimed low-lying land; LGS = land gained on the sea; DL = drained lake

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker

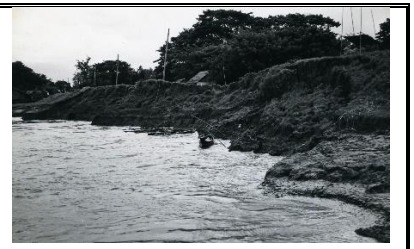
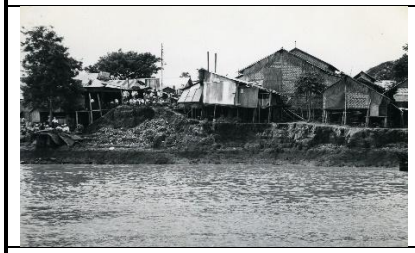
			
A2 001/IX.2.1 Map of Pagan and surroundings along the Irrawaddy, October 1970	A2 001/D1.II.1 Boat, presumably at one of the branches of the Irrawaddy River, 1977	A2 002/D1.II.2 Boat, presumably at one of the branches of the Irrawaddy River, 1977	A2 003/D1.II.3 Bank erosion, presumably along one of the branches of the Irrawaddy River, 1977
			
A2 004/D1.II.4 Bank erosion, presumably along one of the branches of the Irrawaddy RiIer, 1977	A2 005/D1.II.5 Bank erosion, presumably along one of the branches of the Irrawaddy River, 1977	A2 007/D1.II.7 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977	A2 008/D1.II.8 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977
			
A2 009/D1.II.9 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977	A2 010/D1.II.10 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977	A2 011/D1.II.11 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977	A2 012/D1.II.12 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker (continued)

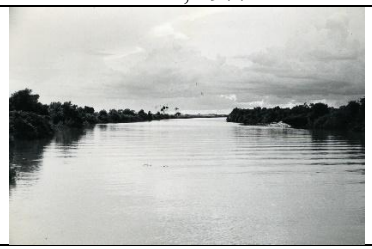
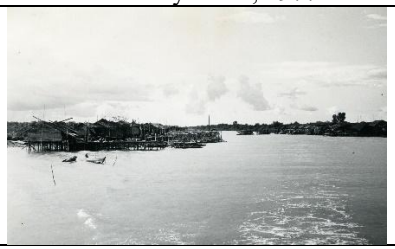
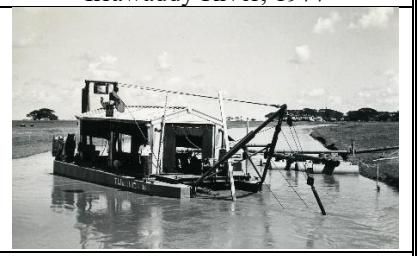
			
A2 013/D1.II.13 Elevated road, possibly towards one of the branches of the Irrawaddy River, 1977	A2 014/D1.II.14 Lowland, possibly along one of the branches of the Irrawaddy River, 1977	A2 015/D1.II.15 Cow at an elevated road, possibly towards one of the branches of the Irrawaddy River, 1977	A2 016/D1.II.16 On board, 1977
			
A2 017/D1.II.17 Presumably one of the branches of the Irrawaddy River, 1977	A2 018/D1.II.18 Presumably one of the branches of the Irrawaddy River, 1977	A2 019/D1.II.19 Presumably one of the branches of the Irrawaddy River, 1977	A2 020/D1.II.20 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977
			
A2 021/D1.II.21 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977	A2 022/D1.II.22 Settlement, presumably along one of the branches of the Irrawaddy River, 1977	A2 023/D1.II.23 Traditional boats, presumably at one of the branches of the Irrawaddy River, 1977	A2 024/D1.II.24 Dredging work, presumably at one of the branches of the Irrawaddy River, 1977

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker (continued)

			
A2 025/D1.II.25 Aerial picture, presumably of one of the branches of the Irrawaddy River, 1977	A2 026/D1.II.26 Aerial picture, presumably of one of the branches of the Irrawaddy River, 1977	A2 027/D1.II.27 Aerial picture, presumably of one of the branches of the Irrawaddy River, 1977	A2 028/D1.II.28 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River, 1977
			
A2 029/D1.II.29 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River, 1977	A2 030/D1.II.30 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River, 1977	A2 031/D1.II.31 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River, 1977	A2 032/D1.II.32 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River, 1977

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker (continued)

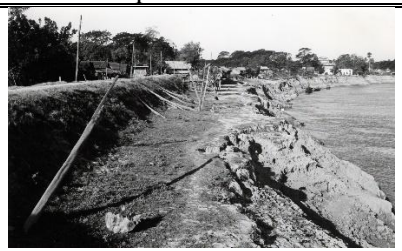
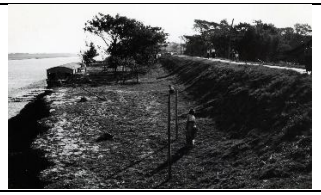
			
A2 033/D1.II.33 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River, 1977	A2 034/D1.II.34 Irrawaddy Delta, bank erosion near Henzada threatening a dike that protects the town. To be prepared for a possible failure, a set back dike has been built to serve as a second line of defence, 1977	A2 035/D1.II.35 Dike in Henzada, 1977	A2 036/D1.II.36 Buildings possibly at and behind a dike in Henzada, 1977
			
A2 037/D1.II.37 Dike with possibly a seepage drain, presumably along one of the branches of the Irrawaddy River, 1977	A2 038/D1.II.38 Dike, presumably along one of the branches of the Irrawaddy River, 1977	A2 039/D1.II.39 Dike, presumably along one of the branches of the Irrawaddy River, 1977	A2 040/D1.II.40 Dike, presumably along one of the branches of the Irrawaddy River, 1977

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker (continued)

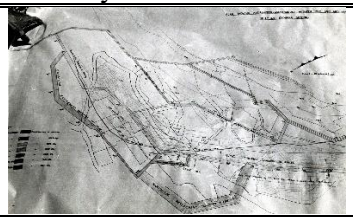
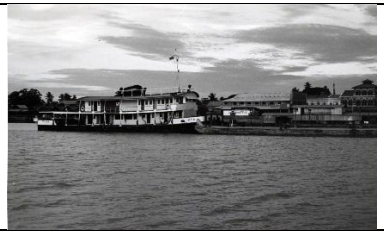
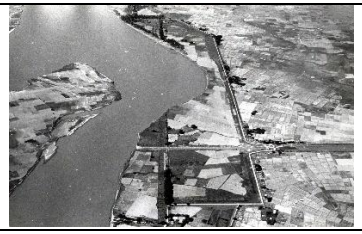
			
A2 041/D1.II.41 Erosion of a dike, presumably along one of the branches of the Irrawaddy River, 1977	A2 042/D1.II.42 Dike, presumably along one of the branches of the Irrawaddy River, 1977	A2 043/D1.II.43 Plan for possibly the reconstruction of a dike, presumably along one of the branches of the Irrawaddy River, 1977	A2 044/D1.II.44 Dike, presumably along one of the branches of the Irrawaddy River, 1977
			
A2 045/D1.II.45 Traditional wood transport, presumably at one of the branches of the Irrawaddy River, 1977	A2 046/D1.II.46 Boat, presumably at one of the branches of the Irrawaddy River, 1977	A2 047/D1.II.47 Boat, presumably at one of the branches of the Irrawaddy River, 1977	A2 048/D1.II.48 Pumped supply of riverwater, 1977
			
A2 049/D1.II.49 Discharge sluice, presumably along one of the branches of the Irrawaddy River, 1977	A2 050/D1.II.50 Irrawaddy Delta, aerial picture of lowland area Mithwechaung. Dike with an inlet sluice for the controlled admission of silt laden water, 1977	A2 051/D1.II.51 Discharge sluice, presumably along one of the branches of the Irrawaddy River, 1977	A2 052/D1.II.52 Traditional boats at the Malleto Chaung, presumably one of the branches of the Irrawaddy River, 1977

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker (continued)

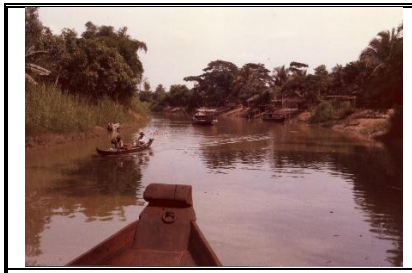
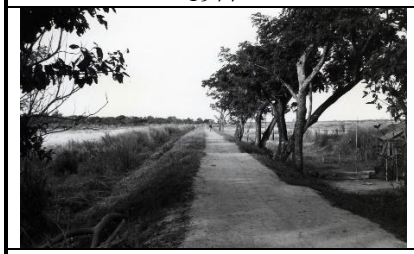
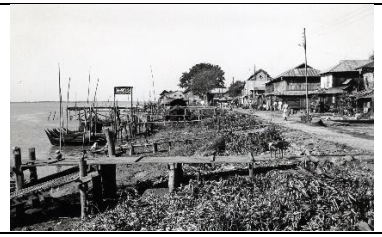
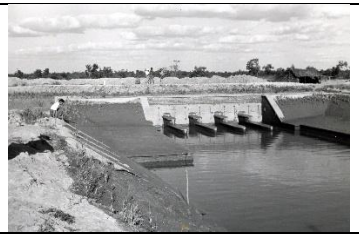
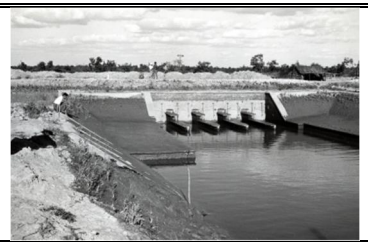
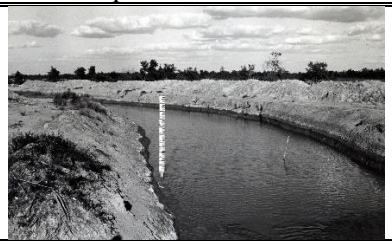
			
A2 053/D1.II.53 Traditional boats at the Malleto Chaung, presumably one of the branches of the Irrawaddy River, 1977	A2 054/D1.II.54 Traditional boats at the Malleto Chaung, presumably one of the branches of the Irrawaddy River, 1977	A2 055/D1.II.55 Traditional wood transport, presumably at one of the branches of the Irrawaddy River, 1977	A2 056/D1.II.56 Traditional wood transport, presumably at one of the branches of the Irrawaddy River, 1977
			
A2 057/D1.II.57 Dike, presumably along one of the branches of the Irrawaddy River, 1977	A2 058/D1.II.58 Dike with road and lowland, presumably along one of the branches of the Irrawaddy River, 1977	A2 059/D1.II.59 Group picture. Prof. Adriaan Volker is right in front, 1977	A2 060/D1.II.60 Landscape in the Irrawaddy Delta, 1977
			
A2 061/D1.II.61 Landscape in the Irrawaddy Delta, 1977	A2 062/D1.II.62 Landscape in the Irrawaddy Delta, 1977	A2 063/D1.II.63 Settlement, presumably along one of the branches of the Irrawaddy River, 1977	A2 064/D1.II.64 Discharge sluice of the Labutta Polder, 1977

Table IV. Pictures of polders and lowlands in Myanmar by Prof. Adriaan Volker (continued)

			
A2 065/D1.II.65 Discharge sluice of the Labutta Polder, 1977	A2 066/D1.II.66 Main drain of the Labutta Polder with staff gauge, 1977	A2 067/D1.II.67 Dike of the Labutta Polder with a guard	A2 068/D1.II.68 Dike of the Labutta Polder
			
A2 069/D1.II.69 Dike of the Labutta Polder	A2 070/D1.II.70 Aerial picture lowland area probably near Bassein, presumably along one of the branches of the Irrawaddy River	A2 071/D1.II.71 Aerial picture lowland area probably near Bassein, presumably along one of the branches of the Irrawaddy River	A2 072/D1.II.72 Aerial picture lowland area, presumably along one of the branches of the Irrawaddy River
			
A2 073/D1.II.73 Staff gauge, presumably in one of the branches of the Irrawaddy River	A2 074/D1.II.74 Dike with road and lowland near Nyaung Thanbin, presumably along one of the branches of the Irrawaddy River	A2 075/D1.II.75 Dike in front of settlement near Shwelaung, presumably along one of the branches of the Irrawaddy River	A2 076/D1.II.76 Settlement near Rangoon, presumably along one of the branches of the Irrawaddy River