SENEGAL

Source: esri

General

Senegal - officially the Republic of Senegal - in West Africa is bordered by Mauritania in the North, Mali in the East, Guinea in the Southeast, and Guinea-Bissau in the Southwest. Senegal also borders Gambia, which separates Senegal's southern region of Casamance from the rest of the country. Senegal covers a land area of almost 19.7 Mha (million hectares) with in 2022 a population of 17.3 million, or 0.88 persons per ha (Wikipedia and United Nations, 2022).

Climate and geography

Senegal has a pleasant tropical climate with well-defined dry and humid seasons that result from northeast winter winds and southwest summer winds. Annual rainfall of about 600 mm occurs between June and October. Rainfall increases substantially farther South, exceeding 1,500 mm annually in some areas. The dry season (December to April) is dominated by hot, dry, wind. Between June and October maximum temperatures average 30 °C and minimums 24.2 °C, December to February maximum temperatures average 25.7 °C and minimums 18 °C. Interior temperatures are higher than along the coast. Near the border with Mali where desert begins, temperatures can reach as high as 54 °C. The northernmost part of the country has a near hot desert climate, the central part has a hot semi-arid climate and the southernmost part has a tropical wet and dry climate (source: Wikipedia).

Climate change in Senegal may have wide reaching impacts on many aspects of life. Climate change is expected to cause an increase in average temperatures over West Africa by between 1.5 and 4 °C by 2050. Projections of rainfall indicate an overall decrease in rainfall and an increase in intense mega-storm events over the Sahel. The sea level is expected to rise faster in West Africa than the global average. Sea level rise and resulting coastal erosion is expected to cause damage to coastal infrastructure. Climate change also has the potential to increase land degradation that will likely increase desertification in eastern Senegal, leading to an expansion of the Sahara (source: Wikipedia).

The Senegalese landscape consists mainly of the rolling sandy plains of the western Sahel, which rise to foothills in the Southeast. The northern border is formed by the Senegal River; other rivers include the Gambia and Casamance rivers. Senegal contains four terrestrial ecoregions: Guinean forest-savanna mosaic, Sahelian Acacia savanna, West Sudanian savanna, and Guinean mangroves.

Mean tidal amplitudes are of the order of 1.0 to 1.5 m, with spring tide amplitudes up to 2.5 m. Sylla (1994) describes that in the Casamance River the tidal amplitude at the mouth is about 1.7 m to slightly over 0.5 m at Ziguinchor some 60 km upstream.

Marius (1982) describes that in Gambia and Senegal the areas with mangroves are concentrated along the banks and beaches in the estuaries of the Casamance, Gambia, Saloum, and Senegal rivers at a total area of about 500,000 ha (Figure 1). Parts of the mangrove areas have been replaced by *tannes*. *Tannes* are areas where the mangroves were cleared for paddy fields or salt pans. Sylla (1994) describes that rice growing in the mangrove zone started in the middle of the 18th century in Guinea and Sierra Leone. Traditional systems are still the most widespread and they are applied, for example in Senegal (diola system), Guinea, Guinea-Bissau (bolanha system) and Sierra Leone. The diola and bolanha systems consist of small basins or strips of land that are surrounded by dikes. Within these polders the rice is cultivated on ridges. Tidal drainage is required to flush the salts and acids that have accumulated in the polders during the dry season.

Since the early 1960s the soils in the mangrove areas have been studied, while after reclamation these soils became acid. Since 1972 systematic soil surveys have been conducted in the three estuaries, resulting in soil maps and relevant physiographic background information. Detailed maps have been made for specific reclamation projects.

The traditional systems of rice cultivation have functioned well until the persisting droughts started in 1969. The most affected zones are mainly in the northern, and drier coastal part of West Africa, including Senegal, Gambia, Guinea-Bissau and to a some extent Guinea.

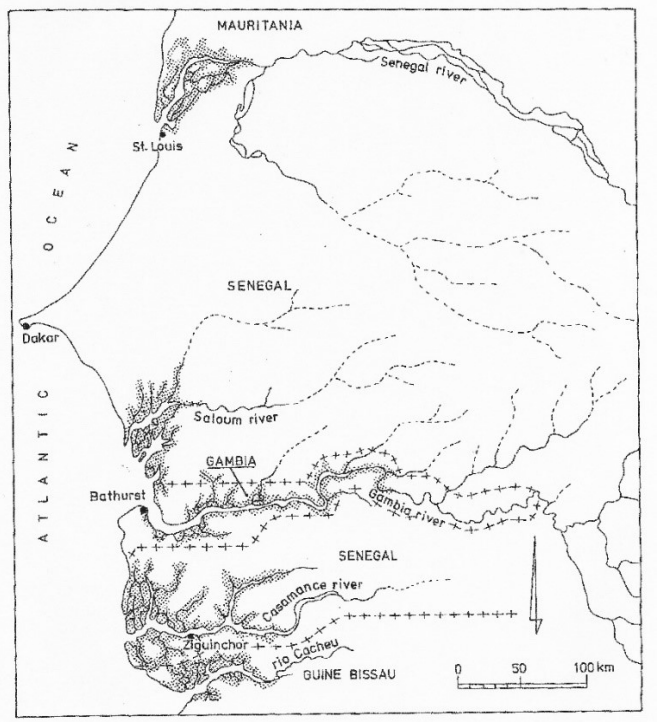

Figure 1. Mangrove area in Senegal and Gambia (Marius, 1982)

Marius (1982) describes that the intertidal clay flats facilitated the construction of small polders. Dikes were 1.0 to 1.5 m high with a crest level of 0.20 m above maximum spring tide level. For sluices hollow tree trunks, preferably of palms, were embedded at various levels in the dike body, enabling the maintenance of various water levels in the polder. The lowest sluice was situated below the original surface with its outlet in the trench. For gates fibrous stops impregnated with clay were used and sometimes wooden flap gates. After clearing a grid of superficial ditches was dug and the excavated flat topsoil clods were laid on the interjacent surface areas to form raised cambered beds of a few square metres each. Impoldering normally started at the inland side of the Rhizophora zone and later expanded towards the river bank. In areas with erosive tidal currents the rice polders were protected by a series of peripheral polders. Moreover, outer dikes were constructed several tens of metres from the banks. Leaving a fringe of mangrove forest in the front land (Figure 2).

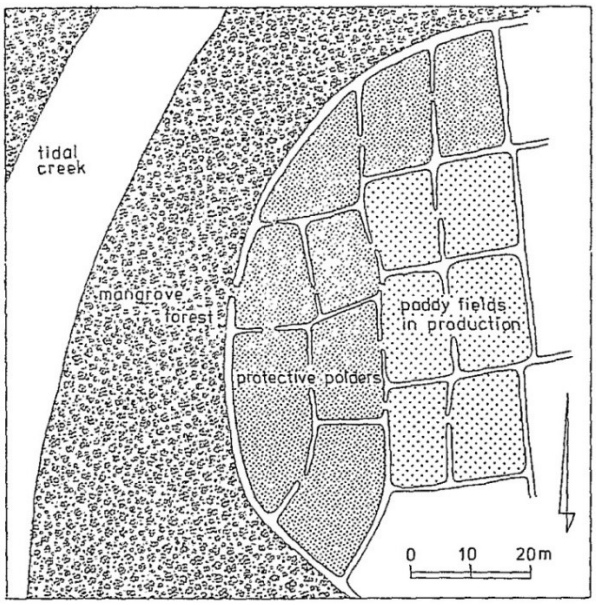

Figure 2. Traditional rice polders in the Casamance estuary (Marius, 1982)

Marius (1982) also mentions that even before 1972 large-scale reclamation projects for paddy production have been realised. The more important ones are situated in the Lower Casamance where the mangrove flats penetrate into the valleys of the tributaries. Upstream of the tidal areas the valleys were dammed to regulate the fresh water supply. Concrete dams with wooden gates in the riverbed exclude saline tides and enable increased drainage capacity. In some polders, reclaimed in 1967, after desalinisation and leaching acidification occurred.

In a report of the International Bank for Reconstruction and Development - International Development Association (1971) reference is made of seven pilot rice development schemes in the Casamance Region that started between 1967 and 1970. In each of them, the approach has been to introduce higher yielding varieties of paddy, to improve cultivation methods and to promote the use of draft oxen by means of a field extension service (Figure 3). In addition, in the case of swamp rice, drainage improvement works were carried out. Together, these projects covered an area of about 3,000 ha of paddy. The project would include the construction of 2000 ha of irrigation and drainage works in swampy areas.

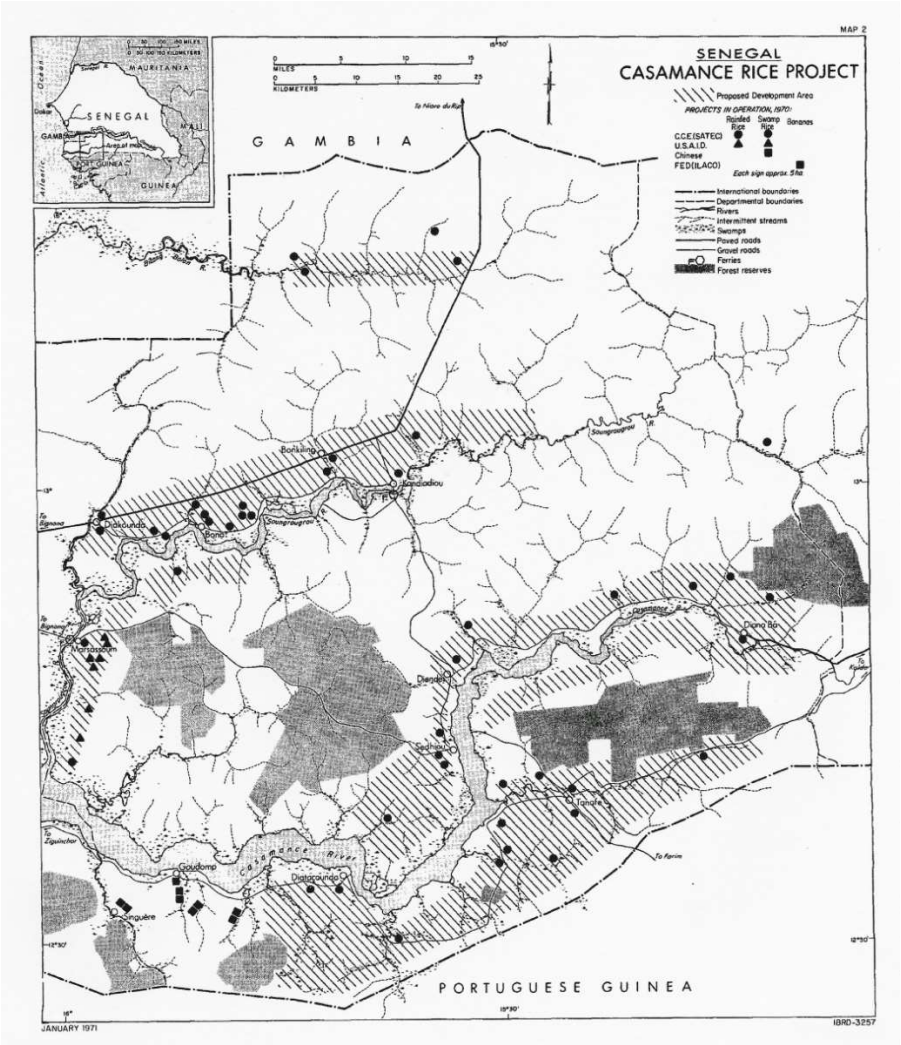

Figure 3. Casamance Rice Project, proposed development area (International Bank for Reconstruction and Development - International Development Association, 1971)

In a World Bank report of 2013 reference is made of actions that would also include construction of intermediate storage and regulatory structures upstream, putting in place small dikes and drainage systems which would not require heavy investments, provision of internal access and crossing structures, and implementation of erosion control systems including agroforestry activities. The project would finance the necessary investments for the development and or rehabilitation of: i) flooded and floodable valleys for rice and aquaculture production; ii) horticulture perimeters. The selection of valleys such as Sofa Niama, Temento (Kolda), Séléky, Tengory and Suelle (Ziguinchor), Médina Souané (Sédhiou)

would be based on specific criteria including areas cleared of landmines, absence of land disputes, existence of youth or women associations, technical feasibility, basic diking facilities (if necessary the dikes would be strengthened by refilling of materials), valleys equipped with salt control dams, and expected impacts. In rice valleys the project would target on lands that had basic dike facilities, but without gate-controlled spillways. This would also be implemented in valleys equipped with salt control dams and for which there were available data. The targeted regions were Ziguinchor and Sédhiou, and to a lesser extent the region of Kolda, based on the existing potential. Eligible activities included works related to rehabilitation of flooded and floodable valleys, and shallows.

Altogether the reports showed that there would be a larger polder area along the rivers, but it was difficult to quantify how large it really was.

General characteristics of the polders in Senegal are shown in Table I. Characteristics of the water management and flood protection systems are shown in Table II.

Existing polders

In a World Bank report of 1972 the Dagana, Debi and Lampsar polders were mentioned (Figure 4). The project included the following: i) construction of an irrigation system in Dagana Polder permitting year-round cultivation of 2,730 ha; ii) improving water control in the Debi Polder and increasing the irrigated area from 260 ha to 1,025 ha; iii) improving water control in the seven ponds forming the Lampsar subproject and increasing the irrigated area from 880 ha to 1,080 ha; iv) strengthening the *Societe d'Amenagement et d'Exploitation des Terres du Delta (SAED)* with staff, facilities, and equipment to carry out the project and to provide support for farmers who use land developed under the project; v) constructing, equipping, and staffing a training centre at Dagana for *SAED* personnel and for farmers; vi) carrying out, through collaboration with *Institut de Recherches agronomiques tropicales (IRAT)*, a program of applied research to support agricultural operations at Dagana; vii) expanding the *SAED* farm machinery pool to permit of land preparation services to farmers using land developed under the project (World Bank, 1972). In the World Bank evaluation report (1979) mention is made of differences in project implementation, compared to the objectives. However, no significant differences in reclaimed areas could be identified.

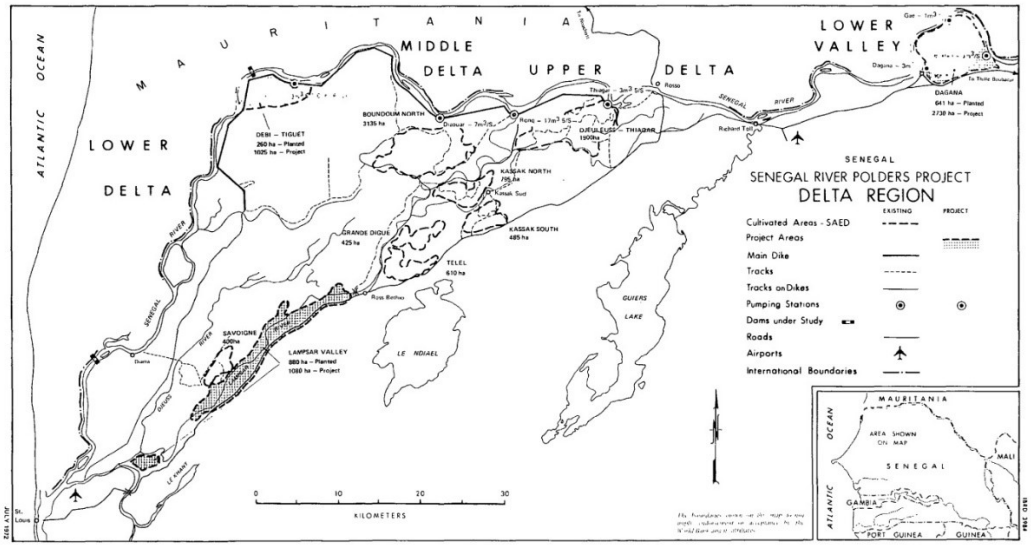

Figure 4. The Senegal River Polders Project area (World Bank, 1972)

The Group Polder Development (1982) provides information on three polders. These are:

- in the framework of the Lower Casamance Project the experimental polders Medina (10 ha) and Dieba (30 ha) (Figure 5). The polders are located in the Delta of the Casamance River;
- the Richard Toll (Casier) Polder along the Senegal River. This is a polder of some thousand ha for the growth of sugar cane.

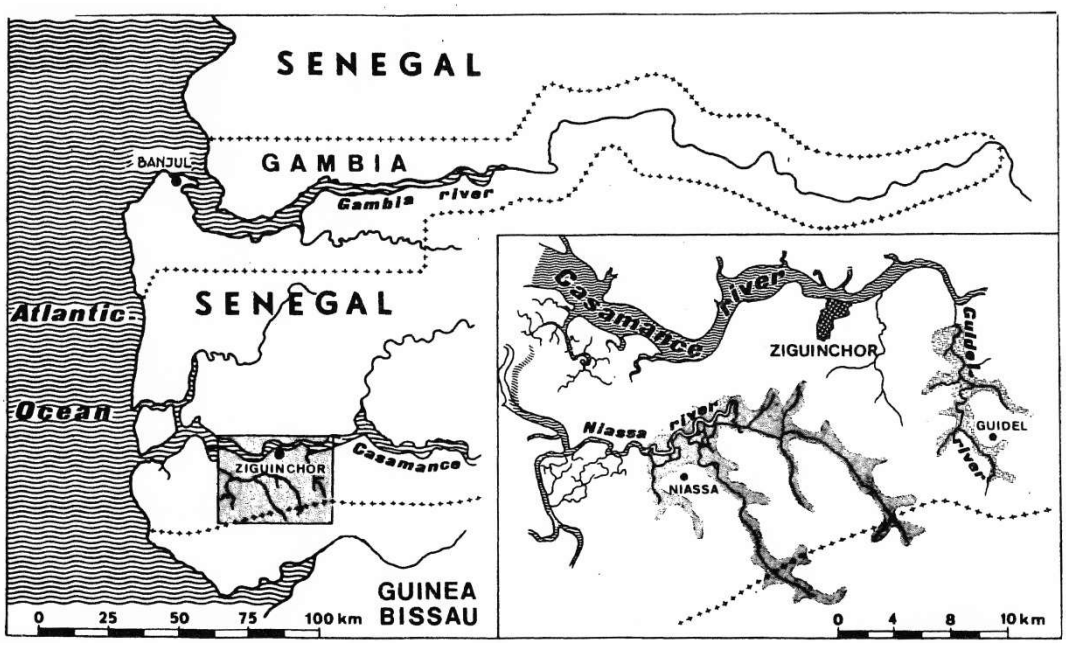

Figure 5. Lower Casamance Project (Group Polder Development, 1982)

Moens and Wanders present the following data on the area of several polders: Lampsar polder 10,000 ha, Dagana Polder 3,000 ha and Nianga Polder 1,000 ha.

In a report of the African Development Fund (2005) it is stated that a project will be implemented in the Lower Casamance River area in lands that have basic diking facilities, but without gate-controlled spillways. The dikes will be strengthened (refilling of materials, fixing with vetiver, etc.) and equipped with control structures. This component will concern schemes undertaken in recent years under the World Food Program (WFP) program (several hundreds of kilometres of dikes), as well as future ones, and will protect about 4,500 ha of land.

Proposed polders

At request of the Senegal River Basin Development Authority, under the title *Fight against weed pests in the Senegal River Delta,* the *Rijksdienst voor Ondernemend Nederland* (2010) invited proposals for the construction of eight polders along the Senegal River. These polders would include 63 km of polder dikes, about 60 km of drains, about 8 pumping systems and at least 8 inlet structures. Four of these polders would be constructed on the Senegal side of the river and four on the Mauritania side. The polders would be located close to the towns of Rosso and Richard Toll along existing agriculture fields. Another important aspect of the project would be the clearance of the Typha – a type of reet - and the preparation of the land in the new polders. The project proposed the creation of polders where the Typha cannot grow: a sustainable solution as it would mean that existing Typha would only have to be cleared once at the start of the project. As soon as the waterline would not be obstructed by Typha anymore, local inhabitants would have easier access to water. The polders would have to create new agricultural ground in which rice and other agricultural products such as vegetables can be grown. In the framework of this programme Royal HaskoningDHV (2013), has produced a master plan to develop the Senegal River Delta and designs for the eight polders with a total area between 3000 and 4000 ha as a pilot project. An artist impression is shown in Figure 6. It has to be verified whether these polders indeed have been constructed.

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

The location of the polders in Senegal is shown in Figure 7.

Figure 6. Artist impression of the proposed polders in the Senegal River Delta (source: Royal HaskoningDHV, 2013)

Figure 7. Location of the polders in Senegal (source: esri – Batavialand)

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Bart Schultz

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Table I. General characteristics of existing and proposed polders in Senegal

Name	Reclamation	Area in ha	Type *)	Latitudes	Longitudes	Elevation in m+MSL	Land use
Existing polders							
Dagana Polder		3,000	RLL	16º 31' N	15º 31' W	7	Agriculture
Debi Polder		1,025	RLL	16º 28' N	16º 15' W	4	Agriculture
Dieba Polder		30	RLL	12º 50' N	16º 02' W	25	Agriculture
Lampsar polders		10,000	RLL	16º 07' N	16º 21' W	4	Agriculture
Medina Polder		10	RLL	12º 49' N	15º 58' W	23	Agriculture
Nianga Polder		1,000	RLL	12º 42' N	15º 15' W	47	Agriculture
Polders in the Lower Casamance River area		4,500	RLL	12º 26' N	16º 33' W	2	Agriculture
Richard Toll Polder		1,000	RLL	16º 27' N	15º 43' W	6	Agriculture
Sub-total		20,565					
Proposed polders							
4 polders in Senegal River Delta							
Sub-total							
Total		20,565					

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

Table II. Characteristics of the water management and flood protection system of existing polders in Senegal

Name	Design criteria in chance of occurrence/year						
	Water management						Flood protection
	Drainage					Irrigation	Rural
	Type	Design criterion	Percentage of open water	Discharge capacity			
				m^3/s	mm/day		
Dagana Polder	RLL						Dikes 0.20 m above spring high tide
Debi Polder	RLL						
Dieba Polder	RLL						
Lampsar polders	RLL						
Medina Polder	RLL						
Nianga Polder	RLL						
Polders in the Lower Casamance River area	RLL						
Richard Toll Polder	RLL						