



# 4

## The Volta Delta, Ghana: Challenges in an African Setting

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### 4.1 The Volta Delta: Evolution and Biophysical Characteristics

Located in south-eastern Ghana between Longitudes 0° 40' E and 1° 10' E and Latitudes 5° 25' N and 6° 20' N, the Volta Delta of Ghana covers an area of about 4562 km<sup>2</sup> (Appeaning Addo et al. 2018)

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(Fig. 4.1). The Volta Delta lies within the Keta Basin, which is one of several fault-controlled sedimentary basins in West Africa (Appeaning Addo et al. 2018). The basin is underlain by acid and basic gneisses and schists of the Dahomeyan system with outcrop on the northern fringes of the basin. The soil underlying the Keta Basin is soft, highly compressible organic or inorganic clays overlaying fine sand to great depth (Kumapley 1989).

The delta plain is almost flat, featureless and descends gradually from inland to the Gulf of Guinea. Several thousand years ago, the river mouth of the delta was located further east but migrated westward (Nairn et al. 1999). The repositioning of the river mouth, decrease in sediment supply and reworking of the Holocene delta plain have resulted in realignment of the delta front east of the present river mouth (Anthony 2015).

The Volta Delta falls within the south-eastern coastal plains climatic zone. Climatic conditions are influenced by two air masses, the dry north-east trade winds and the moist southwest monsoon winds, which

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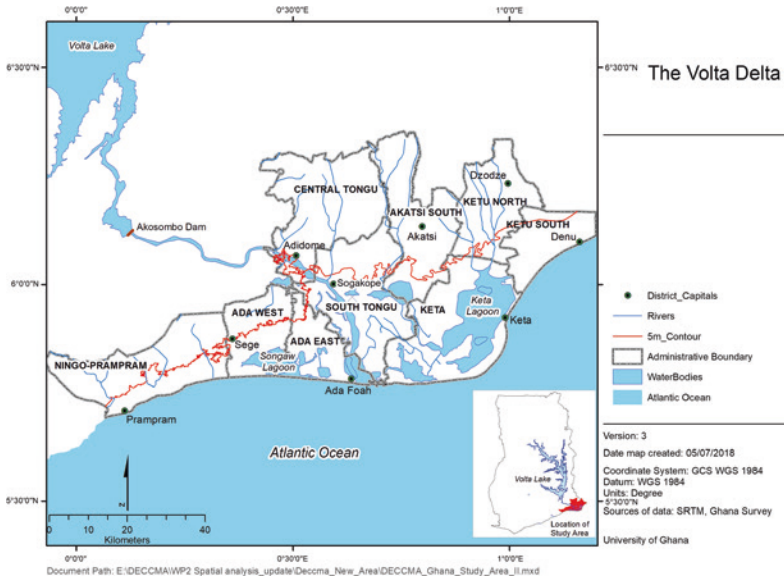
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**Fig. 4.1** Map of the Volta Delta area depicting the 5 m contour boundary of the delta and the nine administrative districts partly or wholly within the delta

produce a double maximum rainfall pattern (Gampson et al. 2017). The major rainy season falls between March and July, and the minor rainy season is between August and November. Mean annual rainfall varies between 146 and 750 mm between years and increases from south of the delta to its north. The dry season occurs from November to February

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and it is characterised by the north-east trade winds (harmattan). The mean temperature does not fall below 25 °C (Awadzi et al. 2008).

Ocean wave action significantly shapes the delta front. Swell waves of moderate to high energy with an average height of about 1.4 metres (m) and a long period of about 11 seconds (s) approach the shoreline unimpeded from the south to south west (Almar et al. 2015). The consistent wave action generates significant longshore currents which transport sediment eastwards, causing one of the highest rates of annual unidirectional longshore sand drift in the world ( $1\text{--}1.5 \times 10^6 \text{ m}^3/\text{yr}$ ) (Nairn et al. 1999). Tides are semi-diurnal with a tidal range of about 1 m and generate weak currents which have limited effect on the shoreline morphology (Appeaning Addo et al. 2008).

The Volta River is one of the main sources of sediment supply to the Gulf of Guinea but its activities have been interfered with by anthropogenic activities. The river's discharge varied between 1000  $\text{m}^3/\text{s}$  in the dry season and over 6000  $\text{m}^3/\text{s}$  in the wet season before the Akosombo Dam was completed in 1965 (Anthony et al. 2015). Runoff before dam construction was 87.5 mm/yr and more varied than the post-dam period at 73.5 mm/yr (Oguntunde et al. 2006). The natural flooding patterns of the area have changed due to the controlled flow of water. In addition, annual sediment transport has drastically reduced by dam construction to only a fraction of the original transport with no peaks in flow discharge (Bollen et al. 2011) (see Chapter 5). The delta comprises extensive swamps, interspersed with short grassland mangrove areas, mainly red mangrove, and savannah woodland (Manson et al. 2013).

## 4.2 Demographic and Socio-Economic Characteristics

Table 4.1 presents a comparison of some key demographic characteristics of the Volta Delta and Ghana. The population of the Volta Delta as defined in Fig. 4.1 was about 850,000 in 2010 constituting about 4% of the total population of Ghana (24.6 million). The population structure has a broad base with people below 15 years constituting about

**Table 4.1** Key demographic characteristics of the Volta Delta and Ghana (Data from the 2010 Ghana National Population and Housing Census [GSS 2013])

Population dynamic	Volta Delta	Ghana
Population	856,050	24,658,823
Proportion of population below 15 years	38.0%	38.3%
Proportion of population aged 65 years and above	7.1%	4.7%
Dependency ratio	81	76
Sex ratio	87.0	95.2
Proportion of female-headed households	41%	34%
Population density (persons per km <sup>2</sup> )	151	103
Total fertility rate	3.6	4.0
Population growth rate	1.6%	2.1%
Proportion urban	33%	52%

a third of the total population of the delta (38%) similar to Ghana nationally (38.3%). Further, the population aged 65 years and above constitutes 7% of the delta population which is much higher than the national level of just under 5%. As such, the dependency ratio (84 dependent-age population per 100 population of working-age [15–64]) in the Volta Delta is higher than the national ratio (76 per 100). While the sex ratio in the delta is lower (88 males per 100 females) compared to the national average (95.2 males per 100 females), the proportion of female-headed households is higher in the Volta Delta (45%) compared to the national average (34%) (Appeaning Addo et al. 2018). A lower sex ratio coupled with a higher proportion of female-headed households in the Volta Delta can be attributed to high out-migration of males (Atiglo and Codjoe 2015).

The population density of the Volta Delta is 151 persons per km<sup>2</sup> compared to 103 persons per km<sup>2</sup> in Ghana. Both the Total Fertility Rate (3.6) and annual population growth rate (1.6%) are lower in the Volta Delta compared with the national averages of 4.0 and 2.1% respectively. About two-thirds of the delta population is rural, however, it is projected that more than half of the population of the Volta Delta will be living in urban areas by 2035 through migration. Increasing population growth and urbanisation have altered the land cover, topography and land use in the delta region, and vegetated land has been converted to agricultural use and settlements (Appeaning Addo 2015).

Regarding socio-economic characteristics, the dominant types of dwelling are the compound house and separate structures, and slightly over 60% of dwelling units are owned by households (GSS 2013). Outer wall materials of buildings are mainly concrete, and cement block. Biomass (wood, charcoal, sawdust, etc.) constitutes the main source of fuel for cooking and kerosene the main source for lighting. However, considering the rapid rural electrification that has occurred in the country over the past twenty years, it is expected that more households will be connected to the national electricity grid (Kumi 2017). This will increase the number of households that use electricity for cooking and lighting. While the main source of water for drinking and domestic use is pipe-borne, unimproved sources, including groundwater from wells and open water sources (30%) are quite common.

The two main ethnic groups in the Volta Delta are Ewe and Ga-Dangme and both are patrilineal. The dominant religion in the Volta Delta is Christianity (72%), followed by Traditional African Religion (22%) and Islam (3%). Illiteracy rate for the population aged 15 years and above is about 30%, with higher illiteracy rates for females compared to males (GSS 2013).

The Volta Delta has a diverse economic system with different but integrated sectors, i.e., agriculture including livestock rearing and fisheries, salt and sand mining, construction, trade, transport and tourism (Codjoe et al. 2017). Agriculture-related activities are very common and important for livelihoods in the delta. The crop production sector employs a higher proportion of females than males (Barry et al. 2005). Females mainly engage in processing and selling of fish and farm produce, while males mostly engage in fishing and crop production (Ayivor and Kufogbe 2001). It is, however, largely small-scale and characterised by unsophisticated technologies or irrigation systems. Coconut, for instance, was a major cash crop in the delta in the nineteenth century. However, in the 1930s, production was affected by the Cape St Paul Wilt disease leading to the collapse of the industry (Eziashi and Omamor 2010). In the last two decades, the services sector, particularly trade, transport and small and medium scale manufacturing, has seen a major boost. In recent times, aquaculture farms have been established in the River Volta and the Keta Lagoon and this industry has

huge potential to supplement declining marine fish stocks in the future (Amponsah et al. 2015; Lauria et al. 2018).

Other emerging economic activities include charcoal burning which involves cutting of trees (Akrasi 2005) and salt production (Barry et al. 2005). Furthermore, coastal sand mining which mainly feeds the booming construction industry in the nearby cities of Accra and Tema, despite being illegal, is a common activity (Mensah 2002; Anim et al. 2013; Wiafe et al. 2013; Jonah et al. 2015). Indeed, this practice negatively influences the sediment budget and has contributed significantly to increased erosion along the coast (Appeaning Addo 2015).

Finally, the Volta Delta has very important tourist attractions such as marine turtle breeding sites located in the estuary at Totope, Lolonya, Akplabanya and Kewuse, bird watching on the Songhor and Keta Lagoons (designated wetlands and Ramsar sites which provide sanctuary for about 80% of migratory birds that transit in Ghana), fetish shrines, sacred groves and traditional festivals. Resorts located on the Volta River provide water recreational activities and attract migrants to work in the tourism industry (Codjoe et al. 2017).

Short to medium term economic projections of the delta show that the manufacturing sector could outpace the agriculture and services sectors, partly due to impacts of environmental changes on agricultural production as well as prospects for future oil production (Adjei et al. 2016). Currently, the delta remains a net importer of goods and services as economic activities are inadequate to satisfy domestic and external demands.

### 4.3 Biophysical and Socio-Economic Drivers of Change

The Volta Delta is a dynamic and rich environment that is constantly changing in time and space (Dada et al. 2016). The delta, formed some thousands of years ago from sediments deposited along the mouth of the River Volta, and has constantly undergone changes since the early Holocene (Nairn et al. 1999). Natural and anthropogenic factors

combine in a complex system to drive such change. In most instances, the anthropogenic factors tend to exacerbate the natural effects. It is to be noted, however, that anthropogenic interventions have not always been detrimental to the environment as laws and policies have been enacted overtime to protect the natural resources in the delta area.

Climate change-related events such as rainfall variability, marine and riverine flooding, drought, sea-level rise, storm surges and increased temperature are some natural drivers of change in the biophysical conditions of the delta system (Apeaning Addo et al. 2018). Human-induced changes occur mainly from interruptions in the hydrology, land use and the landscape. The onset of the rainy season has changed due to climate variability. However, increased rainfall intensity in the rainy season causes frequent flooding in the Volta Delta. The floods degrade the environment, threaten lives, destroy properties, and result in displacement of households. Energetic swell waves, increasing sea-level rise and storm surge aided by relatively low topography also facilitate coastal flooding. The delta coast is dynamic with high crests underlain by soft rocks which naturally expose the coast from Prampram to Aflao to flooding, erosion and shoreline recession (Ly 1980). Erosion in the Volta Delta was first reported in 1929 but posited to have existed since the 1860s, particularly in Keta (Nairn et al. 1999).

A critical characteristic of the Anthropocene delta was the construction of the Akosombo and Kpong Dams in 1964 and 1982, respectively, which drastically reduced sediment supply to the coast. This exposed it to severe wave action and erosion resulting in accelerated shoreline retreat, reduction in fresh water and fish supply down-stream (Ly 1980; Nairn et al. 1999; Tsikata 2006) and also the introduction of water hyacinths that affect aquatic life in the Volta River (Gyau-Boakye 2001). Furthermore, it has been documented that schistosomiasis infections became a public health issue in Ghana after the construction of the Akosombo Dam in the 1960s, which created extensive areas suitable for the breeding of the schistosoma host snails (Paperna 1970). The prevalence of urinary schistosomiasis was below 10% among communities living along the river before damming in 1964 and reached as high as 80–90% after damming by 1971 (Lavoipierre 1973; Barry et al. 2005).



Additionally, the construction of the Tema Harbour in 1955 caused sea wave diffraction on the land along the east coast of Ghana, causing massive erosion (Ly 1980; Tsidzi and Kumapley 2001). Erosion rates of about 4 m per year before the construction of the dams increased to about 8 m per year post-dam construction (Ly 1980). To address some impacts of erosion, the Keta and Ada Sea Defence Projects were undertaken in 2001 and 2013, respectively, by the central government. These were preceded by attempts to protect the shoreline by communities in Keta and its environs, led by their traditional leaders and the government, since 1923. These earlier defence structures from colonial times were constructed with weak local materials which could not withstand the strong sea waves (Akyeampong 2002; van der Linden et al. 2013). After Ghana's independence in 1957, the government undertook a coastal protection project in 1960 using steel sheets to protect about 1,600 m of the Keta Township but these also corroded rapidly (van der Linden et al. 2013).

By 1996, the rate of erosion and flooding had increased, with more than half of Keta and its surrounding towns under water (Ile et al. 2014) displacing more than 10,000 people in communities within Keta and leading to losses in the millions of dollars (Oteng-Ababio et al. 2011; Danquah et al. 2014). The central government therefore undertook a sea defence project to construct a causeway across the Keta lagoon for the coastal highway, reclaim lands lost to the sea and construct houses for resettlement of displaced people (Danquah et al. 2014). Between 2001 and 2004, six groynes were constructed within the Keta area to prevent erosion and to control flooding of buildings between the Keta Lagoon and the sea (Boateng 2009). The groynes were about 190 m in length and 750 m apart (Nairn and Dibajnia 2004). In 2011, the Government of Ghana began the construction of a 30 km sea defence wall at Ada to protect communities against wave action (Anim et al. 2013). The defence structures have had two effects; accretion of the up-drift side and increased erosion of the down-drift side of the shoreline (Wiafe et al. 2013; Appeaning Addo 2015).

In recent times, groundwater extraction for irrigated farming practices which has the potential for enhanced subsidence of the delta at a rate of about 1 mm per annum as pertains in other deltas globally

(Kortatsi et al. 2005; Appeaning Addo et al. 2018), mangrove harvesting which may cause erosion and flooding (Anim et al. 2013), prospecting for oil and gas which is expected to increase the rate of subsidence (Setordzi and Nyavor 2015) and coastal sand mining with the potential of reducing sediment budget and thus increase erosion (Appeaning Addo 2015; Appeaning Addo et al. 2018) are being widely practiced.

#### 4.4 Adaptation to Climate and Non-climate Change

Households and communities in the Volta Delta employ both autonomous and planned adaptation strategies to respond to the multiple threats of climatic and non-climatic stressors. Drought and flooding (both riverine and coastal) are the most common pressures on traditional livelihoods, in addition to land degradation, land-use changes, and increasing population demands on natural resources.

In the delta, as in most parts of the country, the prioritised sectors for adaptation are agriculture, water resources and disaster risk reduction. In the post-dam Anthropocene era, the government and non-governmental organisations have implemented a number of projects and programmes to support communities to deal with the inundation of farmlands and settlements, loss of property, salinisation of groundwater, low agricultural productivity, coastal and riverine erosion, water shortage and increased incidence of water and sanitation-related diseases. Planned adaptation activities have mainly focused on implementing change with improved technologies, building capacity (e.g., climate change awareness and adaptation governance training programmes), providing alternative livelihoods for improving food security, minimising the impacts of flooding on communities through disaster risk reduction and rural-urban development actions, improving ecological functions and services for providing sustainable access to natural resources (such as mangrove regeneration and tree planting), and improving access to water.

Evidence from a household survey carried out in 2016 (see DECCMA 2018) shows that, at the community level, about

three-quarters of households have undertaken one or multiple forms of autonomous adaptation strategies. The main adaptation strategies undertaken by households include modification of labour utilisation which involves the use of hired labour and/or women taking up work outside the home. Also, modifications to housing structures or moving houses entirely are common. As noted earlier, houses are usually made of weak materials and may require regular modification or complete abandonment. Financial capital investments in the form of loans, insurance and joining cooperatives are also common. Among these, insurance is the least employed strategy (not shown). Migration does not feature as a major adaptation strategy among households.

Farming and fishing related adaptation strategies constitute the least used strategies in the delta as a whole. Receiving training in new fishing or farming skills is the least common adaptation strategy in the delta. However, among farming households only, purchasing farm equipment is most common (Fig. 4.2).

The most successful adaptation options for most households are strategies that increase their resilience, reduce disaster impacts and improve

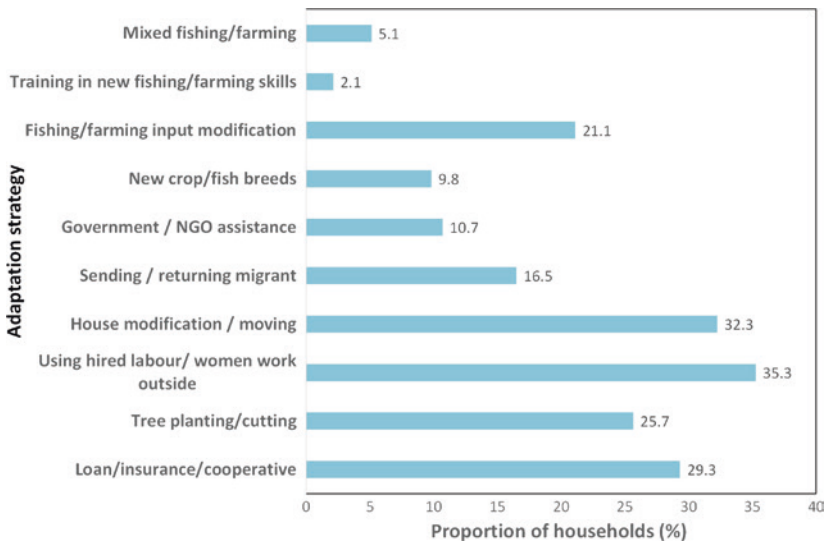


Fig. 4.2 Adaptation strategies by household adaptation strategy in the Volta Delta

living standards by improving their overall skills and capacity for improved livelihood options. Some indications of barriers to successful adaptation relate to project cost implications, the ability of targeted communities/individuals to participate or sustain participation, conflicts between original landowners and related communities over land ownership, and concerns about future loss of biodiversity and downstream pollution from the establishment of commercial agricultural farms. Other barriers include concerns over impacts of constructed sea defence structures on the movement and nesting patterns of sea turtles, the threat of non-indigenous tree species used as buffers along the banks of the Volta River becoming invasive species, and possible interruptions to water supply due to more communities getting connected to the same source.

There are positive influences on the sustainability of adaptation actions due to shared ownership and commitment by the local community through active participation in planning, design and implementation; commitment and financial support (e.g., subsidies) demonstrated by the government; self-generated funds to support action; and the use of cost effective and efficient technologies. Adaptation options that have built in sustainability and ecologically sensitive components are also more likely to be effective in the long-term for reducing disaster risk and vulnerability of the communities, and increasing resilience of the system.

Finally, gendered issues in adaptation were not prominent since both males and females generally have similar perspectives on how effective or successful an adaptation strategy is. However, introducing new breeds in fishing ponds, converting mono-cropped land to mixed farming, employing irrigation farming techniques and relocating to a new house are ranked higher by females, and males rank receiving governmental and NGO intervention and being trained with new skills higher compared to females.

## 4.5 Migration and Resettlement

The first recorded mass migration into the Volta Delta was in the sixteenth century by the Ga-Dangme and Ewe ethnic groups. Ever since this period, there has been migration to and from the delta although

out-migration has been predominant. In the Anthropocene, the Volta Delta is a net migrant sending area, although some districts (South Tongu, Ketu South, Akatsi South, Ada East, Ada West and Prampram) are net-migrant receiving areas. Based on the results of the survey carried out for this research, the main drivers of migration from the delta are economic (employment opportunities), education and family reunion; very few individuals cite direct environmental factors as the main reason for migrating. Furthermore, higher proportions of males, mainly youth, migrate due to economic reasons, whilst more females migrate to reunite with a family or for education. It should be noted, however, that some of the economic or livelihood drivers of migration may be directly linked to climate and/or environmental change.

People who migrate for economic reasons are usually never married, cohabiting or separated. Movements from the delta area are usually permanent and there is continuous mobility from the area. Respondents in male-headed households have a higher proportion of members who intend to migrate compared to female-headed households. Although more than a third of the respondents (42%) in the Volta Delta are of the view that migration is disruptive to individuals and the household, there is a general perception that migration is helpful. The common perception is that migration improves the socio-economic conditions of individuals and households and this feedback may continue to increase future migration from the delta, if economic opportunities are not enhanced in situ.

Some biophysical factors are associated with out-migration from the region. For example, there is already high impact of climate change on farming and fishing activities in the area. Land used for crop and vegetable cultivation and landing sites for fishers have been lost to flooding and erosion, and fresh water fishing and farming in or near the lagoon have also been affected by salinisation (Codjoe et al. 2017). In addition, the construction of the sea defence walls has not attracted people back into areas destroyed by coastal erosion or inundation due to lost livelihoods and rare economic opportunities. It is estimated that future accelerated environmental change due to the impacts of coastal erosion and flooding will lead to mass displacements and high out-migration from affected areas.

Successive governments have considered resettling highly vulnerable communities in the delta. Prior to independence, earlier attempts to resettle communities from the Keta area failed because of the communities' attachment to their place and main livelihood activity, i.e., fishing (Akyeampong 2002). In 1996, the government undertook a comprehensive resettlement scheme for three communities in Keta—Adzido, Vodza and Kedzi (Akyeampong 2002; Afram et al. 2015). According to Afram et al. (2015), resettled communities are generally happy with the housing facilities provided but are dissatisfied with the living arrangements. In particular, people prefer to live close to their extended families and to have spaces around their homes for gatherings such as funerals and marriage ceremonies. Not incorporating these cultural and family contexts result in loss of family and cultural ties, violation of people's fundamental human rights as well as apathy for community cohesion (Danquah et al. 2014).

## 4.6 Delta Management and Policy

As shown in Table 4.2, pre-colonial management of the Volta Delta environment was primarily based on traditional/customary laws which included sanctions, taboos, cultural norms, beliefs, values, codes of conduct, etc. that were handed down over generations by oral tradition, teaching or imitation (Kuupole and Botchway 2010). Management of the delta was vested in chiefs and traditional leaders who ensured that all natural resources inherited from their predecessors were sustained for the next generation (Opoku-Agyemang 2001a). For example, there were customary rules and beliefs which prohibited fishing activities on some days and farming close to the water body or harvesting mangroves, and there were demarcated sacred groves in order to protect the serene and fragile environment (Sarpong 2004; Atampugre et al. 2016).

There is no explicit national policy devoted entirely to the Volta Delta. However, various policies contain focus areas that apply to protecting and conserving some delta features. During colonial and post-colonial times, formal rules in the form of laws, policies, protocols

**Table 4.2** Laws, policies, conventions and ordinances and their impacts on the Volta Delta

Year/period	Policy type	Level	Impact	Source
Pre-colonial era	Traditional/customary laws i.e., taboos, restrictions etc.	Local community	Mangrove protection Fish conservation	Kuupole and Botchway (2010) Opoku-Agyemang (2001a)
Colonial era	River Ordinance, Forests Ordinance	National	Protection of rivers, forests and mangroves	Opoku-Agyemang (2001b)
1971	Convention on Wetlands of International Importance Especially as Water Fowl Habitats: Ramsar	International	Wetland protection	Opoku-Agyemang (2001b)
1981	Convention for the Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan Convention)	International (regional)		Opoku-Agyemang (2001b)
1985	United Nations Convention on the Law of the Sea	International		Opoku-Agyemang (2001b)
1996	Integrated Water Resource Management Policy	National	Groundwater management	
1999	National Wetland Strategy	National	Wetland and wildlife protection	
2001	Water Use Regulation Policy LI 1962	National	Water management	

(continued)

Table 4.2 (continued)

Year/period	Policy type	Level	Impact	Source
2002	Declaration on improved management of natural resources of the Volta Basin	International (regional)		
2006	Drilling for Water and Groundwater Development Regulation Policy LI 1827	National	Groundwater management	
2007	National Water Policy	National	Water management Irrigation management	MWWH (2007) MFA (2011)
2011	National Irrigation Policy, Strategies and Measures Document	National		
2011	National Buffer Zone Policy	National	Protection of buffer zones	MWWH (2011)
Ongoing	National Coastal Policy	National		



and agreements were established to ensure delta management. The earliest documented law on the Volta River Basin in Ghana was the River Ordinance of 1903 (Opoku-Agyemang 2001b) to manage the use of some rivers in the country, including the Volta, and vested powers of control over the river in the colonial governments.

National policies with focus areas that may help protect the delta include the National Water Policy; the National Wetlands Policy; the Tourism Development Policy, Land Management Policy; National Environmental Policy; Energy Policy; Minerals Policy and the Wildlife Conservation Policy. A national coastal policy is currently under development. International protocols that apply to the delta include the Convention on Wetlands of International Importance Especially as Water Fowl Habitats: Ramsar Convention (1971); International Covenant on Economic, Social and Cultural Rights (2000); United Nations Convention on the Law of the Sea (1985); Volta Basin Declaration on improved management of the natural resources of the Volta Basin (2002); Convention for the Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan Convention) (1981).

## 4.7 Conclusion

There has been a transitioning in the Volta Delta from the Holocene to the Anthropocene. It is evident that human activities have greatly altered the physical characteristics in the delta area and the built environment has further reshaped the nature of human settlement, livelihoods and movement. The construction of the Akosombo and Kpong Dams has had tremendous impact, not only on the geophysical characteristics of the delta, but also on the socio-economic adjustments to population livelihoods (see also Chapter 8). The dams have interfered with sedimentation process and repositioning of the river mouth along the Gulf of Guinea and also reduced the amount of freshwater that flows into the sea. Further, the fish population that flowed from upstream has significantly dropped. Thus, there has been outmigration from the delta area to upstream areas for freshwater fishing.

Similarly, the construction of a fishing harbour in Tema, west of the delta has impacted the rates of erosion as well as livelihoods in the delta region. The harbour and an associated industrial city serve as an attractive hub for migrants from the delta whose main fishing-based livelihoods have been adversely impacted by the construction of the dams. Migration is dominated by males leading to a higher proportion of females in the delta.

Currently, the construction of groynes along the coasts of Keta and Ada have resulted in significant rates of accretion and reshaping of the morphology along the shoreline. The Keta sea defence project and accompanying resettlement scheme continue to have some impact on the physical nature of the delta as well as human mobility. The construction of the revetment in Atokor in the Keta Municipality has further enabled the reconstruction of the previously destroyed road and opened up the area for commercial activities. Finally, human settlements, land use and economic activities continue to reshape the land cover and biosphere of the delta area.

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