GHANAIAN SOLAR SALTWORKS: PROMOTING AND PROTECTING THE ECOLOGY

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EXTENDED ABSTRACT

Salt production potential in Ghana is conservatively estimated at between two and a half million tonnes to three and a half million tonnes per annum (2,500,000 tonnes to 3,500,000 tonnes per annum) based on the climatic and environmental conditions prevalent in Ghana.

The production of salt by solar evaporation is the main method used in Ghana.

Three methods of solar salt production have been identified in Ghana, namely:

- Artisanal Salt winning from lagoons during the dry season
- Traditional Solar salt Production on small scale
- Modern Solar salt Production on large scale

Apart from the artisanal salt winning method in which there is virtually no intervention by man in terms of construction of embankments, etc. the two other methods involve the construction of dykes and the use of pumps to control the flow of water.

The salt production areas in Ghana are mainly found in the coastal wetlands which are around the Keta Lagoon, the Songor lagoon, the Densu Delta area, Nyanya lagoon, Oyibi lagoon, Amisa lagoon and Amwin/Benyah lagoon. The total wetland surface area of these is almost 20,000 square kilometers.

Salt production takes place in all the Ramsar sites in Ghana. Incidentally, the two largest Ramsar sites, the Keta lagoon Complex Ramsar site (1010.22 km^2) and the Songor Ramsar site (511.133 km^2) have the highest concentration of artisanal salt winning activity where the lagoons are allowed to dry up completely every year.

The impact of the expansion in the salt industry on the ecology is expected to be immense because of the corresponding increase in wetlands likely to occur.

Keywords: Ghana Saltworks and wetlands'

INTRODUCTION

Salt Production in Ghana is by the solar evaporation of lagoon and/or seawater. The country is in the process of transforming its salt industry into an internationally competitive one to be able to realize its full potential estimated at between two and a half million tonnes to three million tonnes per annum (2,500,000 tonnes to 3,000,000 tonnes).

In order to achieve this aim, the establishment of modern solar salt works is being encouraged and pursued. One benefit of modern solar salt works apart from efficiently utilizing the land and climatic conditions is that they are integrated coastal systems which stabilize the salinity of ponds or lagoons they create.

Ghana has wetlands, some of which are protected (Ramsar sites), but the growth in human population and the pressure of urbanization is making it increasingly difficult to leave so much land space uninhabited by humans.

The establishment of modern salt works and the modernization of the existing traditional salt works is therefore seen as a way of protecting and even increasing the sizes of the wetlands (with all its ecological advantages and implications) economically.

ENVIRONMENTAL AND CLIMATIC CONDITIONS

Land

It is estimated that about 50,000 hectares of land in the coastal region of Ghana can be used for salt production. Land already licensed to be used for salt production is about 28,000 hectares. It is estimated that 40% of this land is being used now for salt production. This figure excludes the surface area of lagoons which are used for salt winning.

Rainfall

The seasonal distribution of rainfall varies considerably over the whole country. The movement of the Inter-Tropical Boundary (ITB) controls, to a large extent the distribution of rainfall over the West African meteorological region.

The ITB oscillates between the coast and latitude 20 degrees North. As it moves north and south, it draws with it the associated weather zones. Thus, in January or February for instance, the region of localized thunder activity and disturbance are south of the Guinea Coast and the whole of Ghana lies in the cold dry North Easterly Trade Winds (Harmattan).

The climate of the coastal lands of Ghana has two clearly defined seasons. The dry season and the rainy season. The rainy season has two maxima; the main one occurring in May/June and the minor one in October. June is the wettest month in Ghana. According to the meteorological information, a narrow coastal belt, receives the lowest rainfall in Ghana during any given year.

The total minimum annual rainfall recorded at the western coastal area of Ghana which happens to be the wettest area on the coast and also in the whole country from the Axim meteorological station over the last 15 years is 1,169.2 mm (in 1998) while the highest was 2,337.2 mm (in 1993).

The eastern coastal area has the lowest rainfall figures on the coast. Data from the Akatsi meteorological station gives a minimum of 679.6 mm (in 1992) and a maximum of 1136.6 mm (in 1997) over the past 15 years.

Air Temperature

The mean temperature along the coastal area has a simple seasonal rhythm, with a February – April crest and in July – August trough. The months with lower mean temperature are July to September, which correspond with the months of higher cloudiness of the year.

The range of average temperatures in the dry eastern area is 23.1 ^{o}C to 33.4 ^{o}C. The average temperature varies from 23.1 ^{o}C to 31.2 ^{o}C in the wet western area of the coast.

Relative Humidity

The relative humidity has the lowest values from December to February. During June to August, it records the highest of the year. The average relative humidity in percentage varies from 75% to 88%.

The lowest relative humidity records correspond with the months of higher evaporative rates.

Wind
The prevailing wind direction is from the southwest all around the year (South-Westerly Trades) which is a characteristic feature of all the costal belt of the country.

Evaporation
The angle of declination for solar radiation is very good in Ghana and this helps to increase the rate of evaporation on less cloudy days to acceptable levels.

Those months with less evaporation values, correspond to those of higher cloudiness and thus, have a lower ratio between the total daily radiation onto a horizontal surface and the daily extraterrestrial.

The average daily net evaporation is estimated to be 4.8 mm in fresh water and 0.85 mm in saturated brine.

Seawater Characteristics
Coastal waters are under the influence of the Guinea Counter Current, which flows in a direction parallel to the coast. This characteristic enhances a normal composition of the seawater, especially during the dry season.

The prevailing winds as already stated are the south westerly trades, which contribute to improve oceanic characteristics of the coastal water.

One important characteristic of the seawater in the coastal belt is the presence of suspended sand particles that occur during the rising tide and from strong waves surfing over the sandy shoreline with wave of over 2 meters.

The average density of seawater is 3.5 ^{o}Be while that for the lagoons ranges from 5 ^{o}Be to 15 ^{o}Be depending on whether it is a closed lagoon or an open lagoon. The density of the lagoon also depends on the season; being higher in the dry season and lower in the wet or rainy season.

SALT PRODUCTION POTENTIAL

It is estimated that the productivity of salt works in Ghana averages 1,600 tonnes per year per hectare of crystallizer area. This is based on an analysis of climatic factors such as temperature, rainfall pattern, humidity and wind speed and the soil characteristics of the areas for salt production in Ghana. The figure is supported by production figures from producers.
The total land licensed[1] to be used for salt production is about 28,000 hectares. Using the productivity given above, the potential salt production of Ghana from solar salt production should be about 3,500,000 tonnes per annum. [This does not include salt production from salt winning activities].
Wetlands have invaluable functions and values which include the following; fish and wildlife habitats, natural water quality improvement, biogeochemical cycling, hydrologic cycle roles, flood storage, shoreline erosion protection, opportunities for recreation, education, research and aesthetic appreciation, economic benefits of natural sand products at little or no cost, and reduction of flood damage.

POPULATION

The population of districts where salt winning and production take place is 4,035,850. This figure includes that of the cities of Accra (1,658,937) and Tema (506400) which are metropolitan in character. The population growth rate is estimated at 2.8%.
Table 1 gives the breakdown of the population figure.

[1] Calculated from Minerals Commission Data on Salt Mining Companies; January 2006

Table 1: Population of Salt Producing Districts in Ghana[2]

DISTRICT	POPULATION
Komenda/Edina/Eguafo/Abirem	112,437
Cape Coast	118,106
Abura/Asebu/Kwamankese	90,013
Mfantsiman	152,855
Gomoa	194,792
Awutu/Efutu/Senya	169,972
Ga	550,468
Accra-Metropolitan	1,658,937
Tema-Municipal	506,400
Dangbe West	96,809
Dangbe East	93,112
South Tongu	64,811
Akatsi	93,477
Keta	133,661
TOTAL	**4,035,850**

The coastal area where salt is produced is generally characterised by poverty, deprivation and environmental degradation (garbage and domestic sewage, pollution and erosion by sand mining). Salt winning is seen as a viable economic venture with rapid returns as opposed to fishing and farming. As a result there has been a gradual increase in the destruction of mangroves for salt winning. Some estimates have put the rate of destruction of mangroves at 20% annually.

The growing poverty in Ghana's coastal areas and increased demands on wetland resources threaten the prospects of achieving ecological sustainability whilst ensuring human wellbeing.

At the turn of the century, there were about 24 salt production companies in Ghana. Of these, 8 were considered to be large to medium whilst the rest were considered to be small scale producers. It is estimated that the industry employed about 5,000 people in direct labour with secondary and tertiary employment amounting to about 15,000 people (Development and Protection of Coastal & Marine Environment: Ghana National Report, 2002).

The potentials of the salt industry include efficiently using the land, creating more secondary jobs, creating more mangrove ecosystems through well managed ponds or lagoons. These potentials will best be achieved with the establishment of modern solar salt works.

SALT PRODUCTION METHODS

Three salt production methods have been identified in the country. These are:

1. Artisanal Salt Winning
2. Traditional Solar Salt Production on a small-scale
3. Modern Solar salt production on a large scale

Artisanal Salt Winning

This mode of production is practised mainly in areas where the population have access to the large coastal lagoons of Keta and Songor. The practitioners of this method basically wait for the dry season when the lagoon dries up and salt is crystallized out. The lagoon bed area is then shared amongst the community members and on a given day everyone goes onto the dry lagoon bed to harvest salt.

[2] Ghana Statistical Service, 2002

Traditional Solar Salt Production on a small-scale
This method is an improvement on the salt winning method. Here the owners have created embankments where they pump in or allow seawater, lagoon water or well water to flow in by gravity through a series of gates. These ponds are known as backwaters. The water is allowed to stand in these embankments for a period of time for the salinity to increase. The water is then pumped or allowed to flow into crystallizers (known as pans) for it to crystallize into salt. This salt is then harvested after which more water is allowed into the crystallizers. This goes on throughout the dry season. It ceases when the rainy season sets in.

Modern Solar Salt Production on a large scale
Producers use the modern solar salt production method which involves the fractional crystallization of various dissolved salts in lagoon or seawater in various ponds as the water is moved from evaporators through concentrators to crystallizers where sodium chloride is crystallized out. The range of salinity of the water in each of the ponds is regulated and is graded with the lower salinities in the evaporators and concentrators (which incidentally occupy about 90% of the land surface area).

Table 2: below gives a typical structure of the evaporating and concentrating zones in terms of surface areas.

Table 2: Percentage of Area of various zones of a Typical Salt work

PHASE	% of total	Salinity (^{o}Be)
First Evaporator	45.9	3.5 – 7
Second Evaporator	30.15	7 – 14
Third Evaporator	8.55	14 – 19
Concentrator	5.4	19 – 23
TOTAL	90	

From the above, about 45% to 70% of the land of a typical modern solar salt work has water with salinity varying from 3.5 ^{o}Be to 14 ^{o}Be. At these salinities most flora and fauna found in wetlands can and do survive.

WETLANDS OF GHANA

On the 22nd of February, 1988, Ghana deposited at the UNESCO Headquarters in Paris an instrument of accession to the convention on Wetlands of International Importance especially as Waterfowl Habitat, which was adopted at Ramsar, Iran.
Ghana, through the Ministry of Lands and Forestry, established six (6) Ramsar Sites under the Wild Animals Preservation Act on the 19th of August, 1999.

The sites are:

- Muni-Pomadze
- Densu Delta
- Sakumo
- Songor
- Keta Lagoon Complex
- Owabi Wildlife Sanctuary.

Apart from the Owabi Wildlife Sanctuary, all the other Ramsar Sites are in the coastal area of the country.

Table 3 below gives the location and size of the designated Ramsar sites.

Table 3: Location and sizes of designated Ramsar Sites in Ghana

RAMSAR SITE	LOCATION	SIZE (Hectares)
Muni-Pomadze	Awutu/Efutu/Senya and Gomoa Districts	9,461.12
Densu Delta	11 km west of Accra	5,892.99
Sakumo	West of Tema	1,364.35
Songor	Dangbe-East district of Greater Accra Region	51,113.33
Keta Lagoon Complex	All or portions of South Tongu, Akatsi, Ketu and Keta Districts of Volta Region	101,022.69
Owabi Wildlife Sanctuary	14 km North West of Kumasi in Ashanti Region	1,310
TOTAL		**170,164.48**

Presently, there are modern solar saltworks in Densu Delta Site and traditional Solar salt production units in the Muni-Pomadze site. The largest sites, i.e. Songor and Keta Lagoon Complex are the sites where all salt winning is done in the country. Together, these form about 90% of all the Ramsar sites in the country.

Granting of licenses to salt producers in the Ramsar sites for the production of salt using mainly the modern solar salt production method implies that the surface area covered by water bodies in these areas will be increased.
These manmade water bodies will be of much more benefit to flora and fauna because the harsh natural unstable and dynamic salinity gradient which relies on tides and the seasons in the lagoons will be eliminated.

FLORA IN WETLANDS

Within the coastal zone ecosystem one generally recognise the following vegetation types:

- Benthic algal zone occupying the intertidal/littoral areas of the shore.
- Zone of straggling grasses, forbs and herbs and coconuts on sand dunes or beachheads.
- Mangroves in the Estuaries and Lagoon areas, Sedge lands in the immediate catchments of lagoons.
- Zone of saline grassland and evergreen shrubs thickets.

The most common flora in the wetlands is mangroves. The major species encountered are *Avicennia* (Esidun), *Rhizophora* (Bakaben), and *Laguncularia* (Ehuntan). Other flora are *Sesuvium portulacastrum* (a herbaceous forb) and *Sporobolus virginicus* and *Paspalum vaginatum* (grasses). There are also mat reeds such as *Cyperus articulatus*, *Sporobolus pyramidalis*. Species of *Thespesia populnea* also occur along side the neem *Azadirachta indica* and grass *Chloris pilosa* and trees *Jatropha sp*. and *Cassia sp.* and milk bush. Where necessary, this vegetative cover is removed for the creation of saltworks.

The mangrove ecosystem is the most productive of the coastal ecosystems which provides extensive varying habitats. There is also zonation of the mangroves and animals to the different salinity levels and depth.

Incidentally, around the Songor lagoon, the area is generally devoid of mangroves. It is bare ground with salt tolerant grass species *Paspalum*, *Sporobolus* and *Chloris* and prickly shrub, *Zanthoxylem xanthoxyloides* and occasionally *Mimosa pigra*.

Likewise, in the Keta Lagoon Complex, the ground cover of the wetlands is made up of salt tolerant grasses like *Chloris*, *Paspalum*, *Sporobolus* and the succulent herbaceous forb *Sesuvium potulacastrum* and the prickly shrub *Zanthoxylem xanthoxyloides* and the trees *Thespesia populnea*, *Hyphaene thebaica* and *Phoenix reclinata* (Savannah date palm).

It is estimated that if at least 50% of the these largest Ramsar sites were developed into modern solar salt production units, about 35,000 hectares of saline lagoons and about 22,000 hectares of hypersaline lagoons will be created and managed. This will promote the growth of mangrove ecosystems.

FAUNA IN THE WETLANDS

Most of the fauna found in the lagoons/estuaries and their wetlands utilize the environment as well as the peripheral zones while shifting from one zone to the other. There are molluscs, crustaceans, fishes, reptiles, birds and mammals.
The mangrove areas again serves as a nursery and feeding ground for fin and shellfishes both migrant and resident, and for migrant waterfowls, turtles, the rare ungulate, *Tragellaphus spekei*, (West African Sitatunga) and other invertebrates and worms.
Birds identified in the Ramsar sites include migrants and resident species. The species include shore birds such as waders, terns, gulls, herons, terns and ducks.

CONTRIBUTION OF COASTAL LAGOONS TO THE MARINE ECOSYSTEM

The coastal wetland habitat forms an integral part of the marine fishing industry. This is because the lagoon environment provides important spawning and nursery grounds for many marine and freshwater fin fish species as well as shell fish.
Degradation caused by human settlements and industrial development other than salt works development causes loss of lagoon resources that prevent marine fish and shell fish from benefiting from the productivity of lagoons.
Of the 20 fish species recorded in 3 Ramsar sites in 1998 (Koranteng *et al*), 40% were typically marine species and included economically important species like flat fish, grouper, snappers, jack mackerel and bonga shad.

A study (Biney, C. A. *et al,* 2004) indicates that all the marine catches of artisanal fishermen use the wetlands as nursery and breeding grounds. The table gives the catches and the method of fishing used by the fishermen.

Table 4: Types of Fish caught by Artisanal Marine Fishermen

Method	Fish Types
Canoe	Horse mackerel, Snappers, Bonga shad, grouper, flat fish
Seine nets	Cassava croaker, shrimps, sardines, Bonga shad
Hook and Line	Mullet, Horse mackerel
Set nets	Burrito, Cassava fish, crabs, sardines.

OBSERVED IMPACTS OF ESTABLISHMENT OF MODERN SOLAR SALT WORKS

Some of the impacts of establishment of modern salt works are:

- Mud flats in which used to be filled with flood waters in the rains increasing the surface acreage for fish development and growth will be replaced with evaporators and concentrators. The advantage is that, these evaporators and concentrators are always filled with water with a stable salinity all year round.

- The only area in a modern solar salt work where soil is compacted is the crystallizer zone and not the evaporator and concentrator zones. The area for crystallizers is usually just a tenth or a twelfth of the total surface area. The area for evaporators support flora and fauna since the soil is not compacted and the salinity of the water supports fish life.
- To protect the embankments from erosion, grasses are planted on them. This will increase the area covered by grasses in the wetland, and thereby increase the habitat of those species which depend on the grasses.
- Areas with established mangrove vegetation are not economically suitable for the establishment of the crystallizers in a solar work because of the high seepage losses which may occur in those areas. These areas are therefore protected or left untouched. On the other hand, the evaporator areas will be developed into managed mangrove ecosystems.
- Construction of embankments is cost effective when well-planned and only areas where embankments are to be constructed are disturbed.
- Establishment of salt works creates buffer zones which contain and checks other growing human activities and increasing population which encroach on wetlands.
- Fish cultures are easily integrated into modern salt production activities.

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