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# Comparative analysis of the socio-economic characteristics of Delta and Non-Delta spaces of Ghana: An input-output approach

Prince Osei-Wusu Adjei*[1], Ignacio Cazcarro[2], Iñaki Arto[3], Patrick K. Ofori-Danson[4], Joseph K. Asenso[5], Emmanuel Ekow Asmah[6], Samuel Nii Codjoe[7], Kwasi Appeaning Addo[8] and Samuel K. Amponsah[9]

[1]Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

[2,3] Basque Centre for Climate Change, Spain

[4,7,8] University of Ghana, Legon, Ghana

[6] University of Cape Coast, Ghana

[5] Ministry of Finance and Economic Planning, Ghana

[9] Food Research Institute, Accra, Ghana

[*] Corresponding author: princeosei2@hotmail.com / poadjei.cass@knust.edu.gh

**Abstract**

This paper provides insights into the current socioeconomic and biophysical state of the Volta Delta, Ghana. We employed non-survey methods, notably the Flegg Location Quotient (FLQ) method of regionalization and construction of tables to develop environmentally extended input-output (IO) model for comparing the economic characteristics of the Volta Delta and the rest of the country. The main sources of data for doing the regionalization were District Analytical Reports. Results from the study indicate that the agricultural sector, trade and transport activities are much predominant in the delta than in the non-delta region. However, employment in services of public administration, financial and insurance, construction and crop production is higher in the non-delta than in the delta region. From a gendered perspective, the embodied work of women in the delta is high in services and manufacturing sectors, but less predominant in agriculture and fishing (compared to the males' participation). Overall, the delta is found to be a net importer (embodied in goods and services from other regions, higher than in exports) of all the economic metrics used in the study, including agricultural land use, employment, energy and $CO_2$ emissions.

**Keywords:** Economic activities; Volta delta; Non-delta; Land use; Employment; Sector productions; Ghana.

## 1. Introduction

Climate change and its associated implications are currently attracting policy, academic and development attention globally (Yeboah, 2011). In recent times, the Volta Delta in Ghana and other similar deltas worldwide have come under intense climate change threats with their socioeconomic implications assumed in most cases (Ofori *et al*., 2016). Empirical evidence on economic impact of climate change for deltas, which explains their vulnerabilities and/or sustainability, is still sketchy in development literature. Therefore, a model that is able to capture the economic impacts of climate change in delta spaces based on a more robust methodology is necessary. Such models allow policy makers to see how different climate scenarios could affect the economic options of highly vulnerable spaces, and enable them to appreciate the need for economic policy reform to guarantee the sustainability of deltas and other vulnerable regions.

Even though variants of the Simple Location Quotient (SLQ) (with Global Trade Analysis Project (GTAP) and Input-Output) method recently developed have been defended as superior and much robust regionalization method for economic analysis (Tohmo, 2004; Flegg and Webber, 2000; 1997), existing studies on economic impact assessment often follow alternative designs (Rushton et al., 1999). Hence, in this paper, we employ data regionalization approach with Input-Output analysis to examine the socioeconomic context of the delta and Non-delta spaces of Ghana. The primary objective of this work is to provide a systematic overview of the structure and functioning of the Volta Delta and Non-delta economies as a necessary step for modelling the economic impact of climate change in the Volta Delta.

This paper discusses the Volta Delta input-output socioeconomic analysis outcomes for establishing the baseline and present state of the Volta Delta with emphasis on the socioeconomic context. Spatial and gender relations as well as interdependencies between the Volta Delta and other related economies (which are – the rest of the country (Non-Delta) and the rest of the world (RoW) through the supply chain up to the final demand of goods and services are discussed. The next section presents the geophysical and demographic context of the Volta Delta, then summary of the methodology used, results and discussion, and the concluding section.

## 2. Geophysical and demographic context

The Volta Delta located at the lower part of the Volta basin with about 181 towns and villages is inhabited predominantly by farmers and fishermen. The

Volta Delta constituting the DECCMA study area covers a total area of about 3,301km$^2$ with an estimated total population of 945,827. The area falls within the geological setting referred to as the Keta basin between Latitudes 6$^o$ 8' and 5$^o$ 45' North and longitude 0$^o$ 17' and 1$^o$ 5' East. The basin is filled with 870m of Paleozoic marine and non-marine sediments. This soft geology generally comprises quaternary rocks and unconsolidated sediments made up of clay, loose sand and gravel deposits (Akpati, 1978). The Delta consists of a larger drainage basin, broad delta plain, narrow shelf, steep upper slope, and a large basin floor. The Volta Delta lies primarily in the coastal savannah zone. Its vegetation is primarily swampy, interspersed with short grassland and clumps of bush and trees, mangrove areas and the savannah woodland. Figure 1 shows the physical map of the Volta Delta with its varied land cover characteristics.

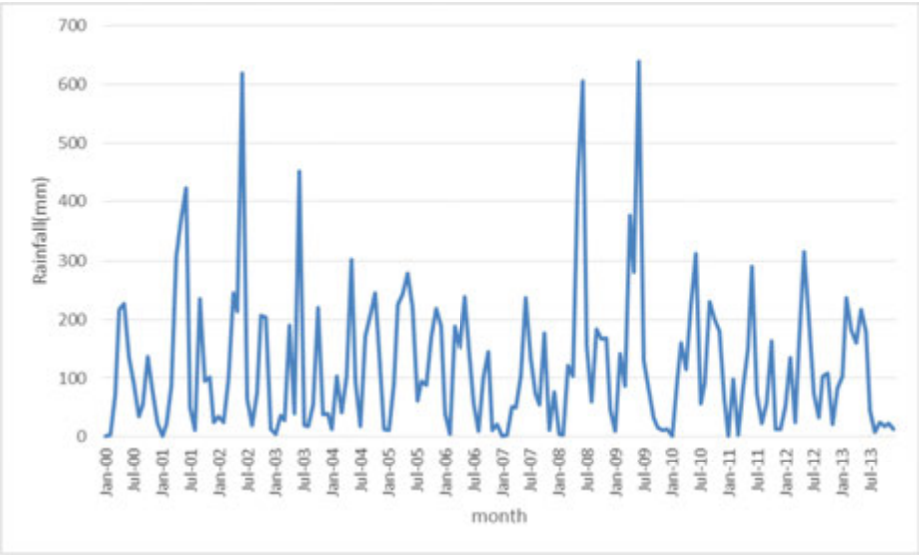
Figure 1: Map of the Volta Delta Region depicting the extent of the study site


*Source:* DECCMA Work Package Two team at Geodata (Southampton)

With regard to its climatic conditions, the Volta Delta lies within the wet semi-equatorial and the dry equatorial climatic zones. The climatic conditions of the region are influenced by the Southwest monsoon winds twice a year resulting in a double maxima rainfall pattern: the major rainy season falls between March and July, and the minor season begins in August and ends in November. The annual

average precipitation of the region varies between 146mm and 750mm. From November to February, the north-east harmattan winds dominate, giving rise to a long dry season in the region (Awadzi *et al*., 2008; Allersma and Tilsman, 1993). Generally, it is observed from longitudinal data on the Volta Delta that rainfall levels in the region are highly erratic (Naumann, 2014). Rainfall levels are high in the major and minor raining seasons and low in the dry seasons (refer to Figure 2). Between 2000 and 2013 for example, the maximum rainfall level observed was 639mm and the minimum was 1 mm.

Figure 2: Rainfall patterns in the Volta Delta from 2000 to 2013




*Source:* Ghana Meteorological Agency (2014)

Temperatures in the Volta Delta are relatively high with mean monthly temperature of about 30ºC in the warmest month (March) and about 26ºC in the coldest month (August). The population distribution of districts in the Volta Delta area is shown in Table 1. The boundaries of some of the districts (e.g. North Tongu District, Ketu Municipal, etc.) extend beyond the delta area.

Table 1:Population Distribution in the Districts of the Volta Delta Region

| Districts | Males | Females | Totals |
|---|---|---|---|
| Ningo Prampram | 33514 | 37409 | 70923 |
| South Tongu | 40019 | 47931 | 87950 |
| Central Tongu | 27790 | 31621 | 59411 |
| Ketu North | 46551 | 53362 | 99913 |
| Keta Municipal | 68556 | 79062 | 147618 |
| North Tongu | 42492 | 47285 | 89777 |
| Akatsi South | 45497 | 53187 | 98684 |
| Ketu South | 75648 | 85108 | 160756 |
| Ada East | 34012 | 37659 | 71671 |
| Ada West | 28579 | 30545 | 59124 |
| **Total** | **442658** | **503169** | **945827** |

*Source:* 2010 Population and Housing Census, Ghana Statistical Service

## 3. Theoretical and empirical literature review

Coastal areas generally and delta regions in particular exhibit diverse economic activities; they are usually densely populated with rich biophysical environment (Appeaning-Addo *et al*., 2018). According to Cazcarro *et al*. (2018) the calculated economic value of goods and services provided by coastal ecosystems have shown that, altogether, coastal ecosystems contribute about 77 percent of global ecosystem-service values. In addition, Gordon and Pulis (2010) note that fish capture, processing, marketing and associated services constitute a significant source of livelihood in coastal areas, and one fishing job has potential to create seven additional livelihoods. Thus, the ecological, economic and social importance of coasts have earlier been studied and highlighted. However, there has been relatively little work done on multipliers in fisheries and other related coastal livelihoods; but agriculture including fishing nonetheless remains a critical economic driver in coastal regions including deltas.

Aside their economic values, coastal areas particularly deltas are identified as especially vulnerable to climate change with potential social and economic implications (Cazcarro *et al*., 2018; Nicholls *et al*., 2011; Ericson *et al*., 2006). Variation in environmental conditions of deltas through changes in temperature, rainfall, salinity, nutrients, storm flooding, land availability etc. create spaces for livelihood vulnerabilities which ultimately undermine income and employment opportunities of people engaged in agriculture including fishing, and other major sectors of delta economy. Coastal areas that are particularly exposed to a range

of hazards connected to climate change can result in a suite of socio-economic impacts on the coastal zone including loss of properties and coastal habitats, loss of tourism, recreation, transportation functions which can produce land use changes (Torresan *et al*., 2008).

Since 1990 major efforts have been made to develop guidelines and methodologies to assess the extent of coastal vulnerabilities including economic resource vulnerabilities and/or sustainability (Klein and Nicholls, 1999). Hence, it becomes necessary to analyse and take stock of the economic characteristics and resources of deltas in relation to non-delta regions as means of establishing potential vulnerability and or sustainability in the phase of climate change threats to coastal environments. Variants of the Simple Location Quotient (SLQ) (with Global Trade Analysis Project (GTAP) and Input-Output) method recently developed have been defended as superior and much robust regionalization method for economic analysis (Tohmo 2004; Flegg and Webber 2000; 1997). However, existing studies on economic impact assessment often follow alternative designs (Rushton *et al*., 1999). Hence, this study was done following the SLQ to analyse the economic characteristics of the Volta delta under threats of climate change to contribute in filling the identified empirical and methodological gap.

## 4. Methodology

A non-survey method, notably the Flegg Location Quotient (FLQ) method of regionalization and construction of tables, is used to develop environmentally extended input-output (IO) model for analysing the economic characteristics of the Volta Delta and the rest of the country. This allows studying elements such as labour, gender, land, environmental embodiments and footprints. In order to study the effects of alterations such as demand changes or climate change in these areas, interdisciplinary knowledge and models were required. These allow one, for example with a classic model of Leontief demand, to see how domestic demand (households, private institutions, government etc.) and external (exports) requirements influence levels of labour and resource use, which may well find availability limits.

The most recent dataset from the Global Trade Analysis Project (GTAP) version 9 with detailed accounts of regional production and consumption, bilateral trade flows, land use, energy flows, and CO2 emissions, all for the base year 2011 was used (Narayanan *et al*., 2015). The GTAP database is aggregated toward a composite dataset that accounts for the specific regional requirements

of the analysis. Regarding the data regionalization and update, the departure matrix of the region, surrounding or neighbouring regions with an economy similar to the one under consideration, which in this case is the country table for 2011 of GTAP 9 was first chosen. Variants of the Simple Location Quotient (SLQ) method[1], which has been recently developed and defended as superior regionalization method was adopted for this study (Tohmo, 2004; Flegg and Webber 1997, 2000). The main sources of data for developing the regionalization were District Analytical Reports. Thus, emphasis was put on the insights for regionalization and construction of Input-Output table for the study of Volta Delta. In particular, the general approach taken for all the Deltas being studied under the DECCMA Project was first described. This consisted of gathering socioeconomic and biophysical information to develop the environmentally extended input-output (IO) tables and models, distinguishing the (DECCMA definition[2] of the Deltas) Delta and the rest of the country (without the delta, which for simplicity is termed "Non-Delta", while the vectors referring to the exports to and imports from other countries) are labelled – "Rest of the world (RoW)". Then emphasis was placed on the particularities for the construction of the input-output table of the Volta Delta based on which this paper was written.

## 5. Results and discussion

### *5.1. Distribution of Value Addition*

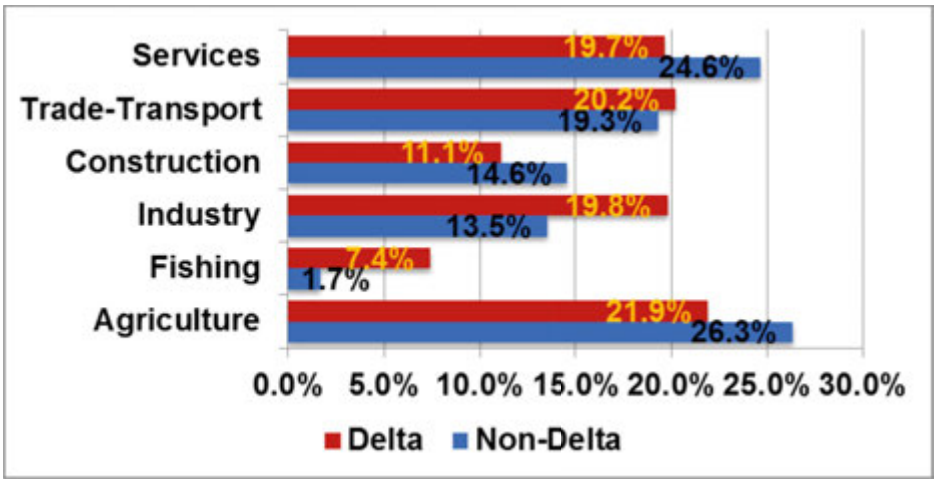
The results in Figures 3 and 4 are based on aggregations of 6 and 16 sectors respectively, out of the 57 sectors of the GTAP version 9. The results from the simulation reveal the importance of the agricultural sector which accounts for approximately 21.9 percent of the delta's economy. Agriculture is also found to constitute the largest share of the non-delta economy, with a share of 26.3 percent, as shown in Figure 3. This indicates that agricultural activities elsewhere in the country are more pronounced than in the delta. Fishing was found to have a higher share of the delta economy (7.4%) than in the non-delta economy (1.7%). These findings confirm earlier works by Cazcarro *et al*. (2018) and Gordon and Pulis (2010). This is also a testament that the inhabitants of the delta, given its location at the Volta Lake catchment area, are more predisposed to engage in fishing than the Non-delta (Bee and Russell, 2007).

[1] Several studies among the earliest ones identified and defended the Simple Location Quotient method (Schaffer and Chu 1969a, 1969b; Morrison and Smith 1974; Eskelinen and Suorsa 1980; Sawyer and Miller 1983). For the purpose of brevity, the GTAP codes and processes for the construction of the Volta delta input-output tables have not been presented in this paper but would be made available upon request.

[2] 5 metre contour.

The results confirm available information that the delta and non-delta economies are service-oriented (i.e. when Services and Trade-Transport are combined) (Bie *et al*., 2015). Given the informal nature of both the delta and Non-delta (Francis *et al*., 2011), it is not surprising that apart from agriculture, trade occupies a predominant aspect of economic life particularly within the Volta Delta. Trade has an intense linkage with transportation and other services, hence, it is expected that this sector is also predominant (Márquez-Ramos, 2015). The contribution of construction is also significant in the delta (11.1%) and Non-delta region (14.6%), which underscores the labour dynamics of Ghana's economy.

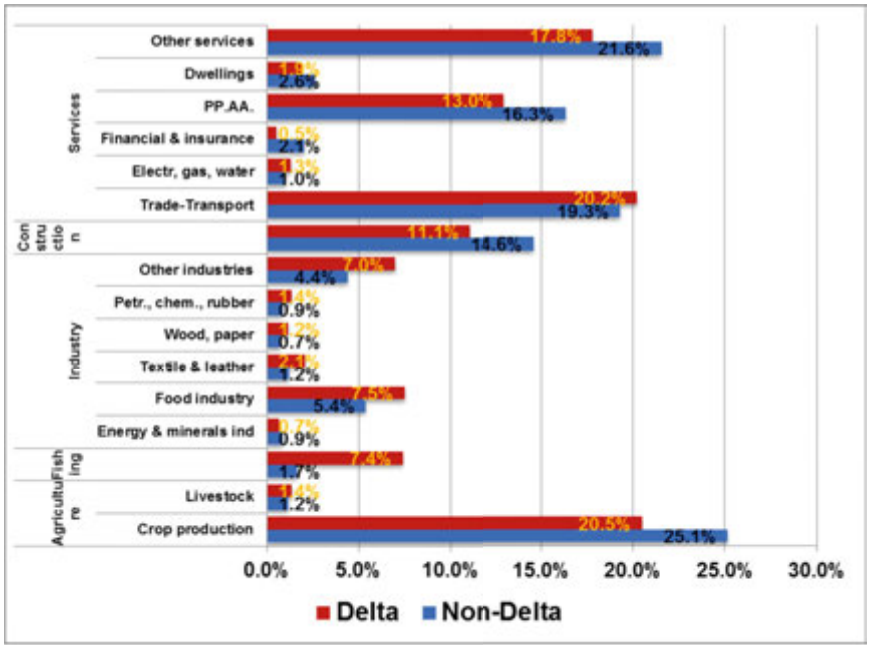
Figure 3: Distribution of value added across the 6 main sectors of the Volta Delta




*Source:* Elaboration from the computations with the IO table and extensions of the Delta and rest of the country

Further disaggregation of the delta and Non-delta economies into 16 sectors confirms the results in Figure 3 and reveals the subsectors which drive the contributions of the 6 main sectors shown in Figure 3. Crop production is found to constitute the bigger share of agriculture, compared with livestock, as shown in Figure 4. The results show that crop production is more pronounced, in relative terms, in the Non-delta than within the Volta Delta (Sobczak *et al*, 2002). This is consistent with the fact that the food basket of the country is the middle and upper belts of the country, as compared to the coastal belt, while the coastal belt (where the Delta is located) is known for its dominant fishing activities.

FIGURE 4: DISTRIBUTION OF VALUE ADDED BY 16 MAIN SECTORS OF THE VOLTA DELTA



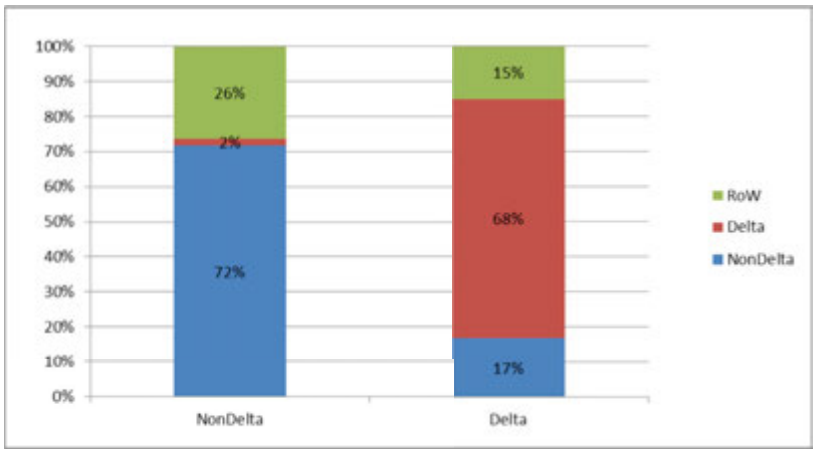

*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

## *5.2. Labour and gender embodiments*

The discussion below focuses on the level of employment created by the respective regions (Delta and Non-delta) for the labour force of the delta, Non-delta and rest of the world (RoW). The results in Figure 5a reveal that about 72 percent of Non-delta labour produces to satisfy the final demand of the Non-delta region itself, 2 percent produces to satisfy the final demand of the delta and 26 percent produces to satisfy the final demand of the RoW. Whereas, about 68 percent of the delta labour produces to satisfy the final demand of the delta itself, 17 percent to satisfy the final demand of the Non-delta and 15 percent of labour within the delta produces to satisfy the final demand of the RoW.

Employment by sector within the delta confirms the results in Figure 5a. The results in Figure 5b indicate that majority of the people (i.e. 94,000) in the service sector within the Volta Delta work to satisfy the final demand of the delta itself, while 24,000 of the people in the service sector work to satisfy the final demand of the Non-delta and about 18,000 working to satisfy the final demand of the RoW. In the agricultural sector, majority of the people are found working to satisfy the final demand of the delta itself, followed by the Non-delta and the RoW, as shown in Figure 5b.

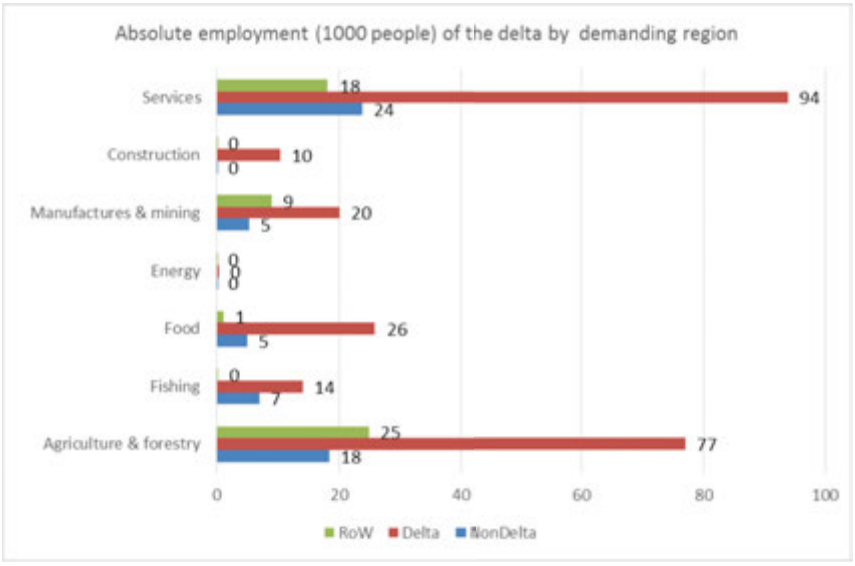
FIGURE 5A: EMPLOYMENT OF THE DELTA BY DEMANDING REGION




*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

Figure 5a shows the relatively modest contribution of the delta demand in the Non-delta employment. Even though the delta represents a relatively smaller area, still in absolute terms, it represents an employment of 187,000 people who work to satisfy the final demand of the delta. On the other hand it was observed that, employment in the Delta (i.e. 355,000 people) has a smaller proportion (less than 20%) that works to satisfy the final demand of the Non-delta and the RoW.

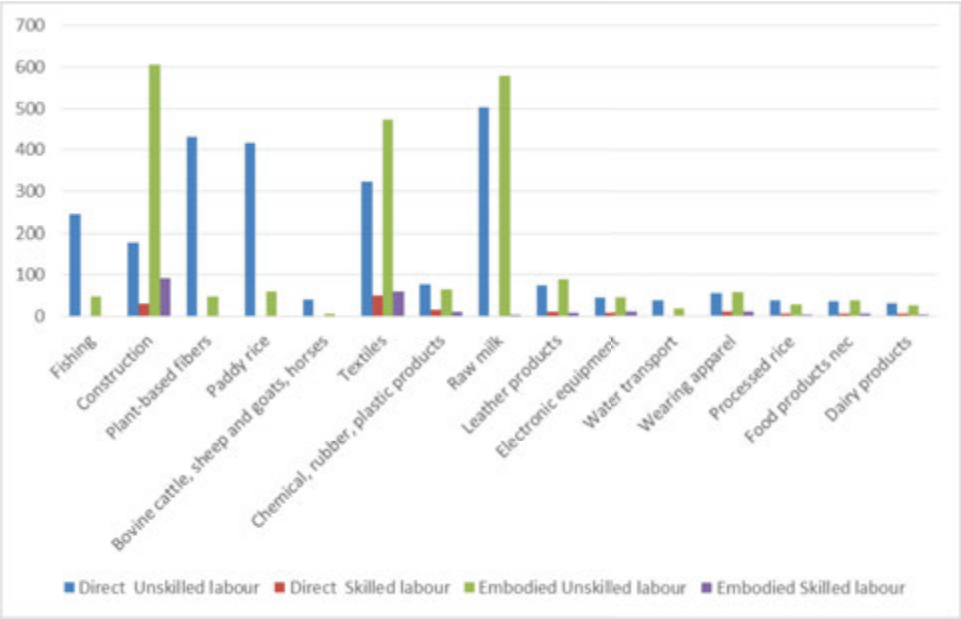
FIGURE 5B: EMPLOYMENT OF THE DELTA BY DEMANDING SECTOR




*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

Further, Figure 6 builds on the results shown in Figures 5a and 5b by indicating the distribution of skilled and unskilled labour across industries within the Volta Delta. From the foregoing, embodied unskilled labour is quite active in the construction, textiles and raw milk industries, while direct unskilled labour is prominent in the aforementioned industries and paddy rice production. Skilled labour for the two categories is significantly present in construction and textiles than elsewhere. To a larger extent, this could be due to the technical supervision that these two industries require.

FIGURE 6: DIRECT AND EMBODIED LABOUR OF THE DELTA BY SECTOR

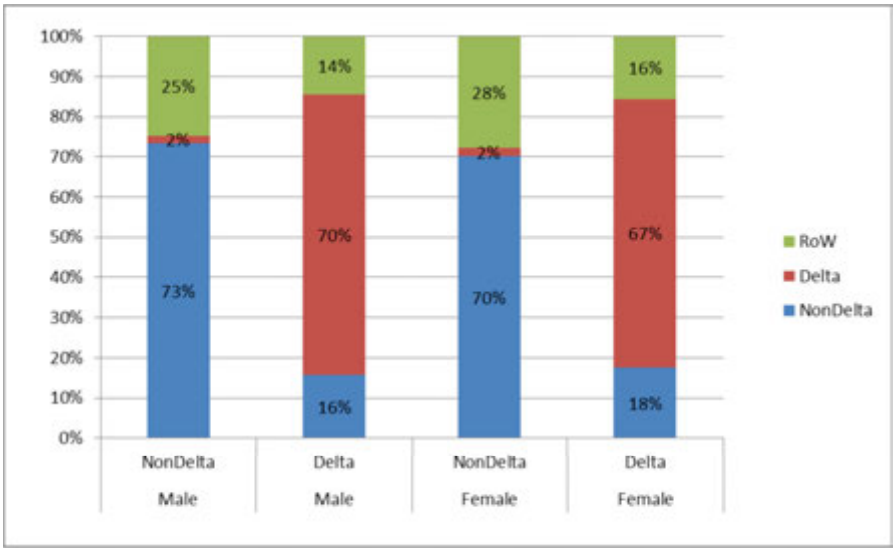



*Source:* Elaboration from the computations with the IO table and extensions of the Delta

With regard to employment distribution by gender across regions, the results shown in Figure 7a reveal that, out of the total males employed by the Non-delta, 73 percent works to satisfy the final demand of the Non-delta itself, 25 percent for the RoW, while 2 percent works to satisfy the final demand of the Volta Delta. Likewise, of the males employed in the delta,70 percent works to satisfy the final demand of the delta region itself, 14 percent satisfies the final demand of the rest of the RoW and 16 percent, the Non-delta. This trend is not different for female employment across the demanding regions. Whilst majority of females within the delta work to satisfy the final demand of the delta itself, majority of females within the Non-delta region work to satisfy the final demand of the Non-delta itself as shown in Figure 7a. This implies that, both within the

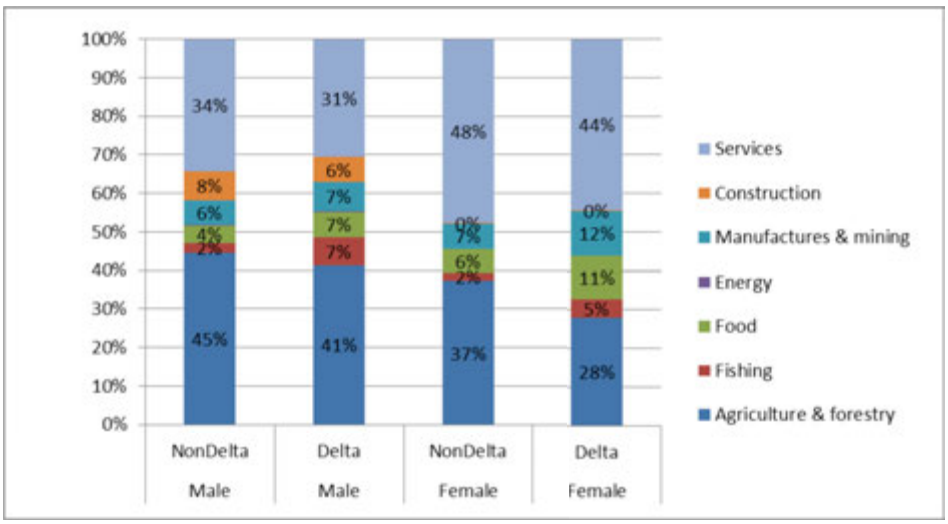
delta and Non-delta regions, the different gender categories of labour work to satisfy local consumption.

Figure 7a: Employment by gender of the Non-Delta and Delta by demanding region




*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

Figure 7b: Direct and embodied labour by sector and gender in the Non-Delta and Delta

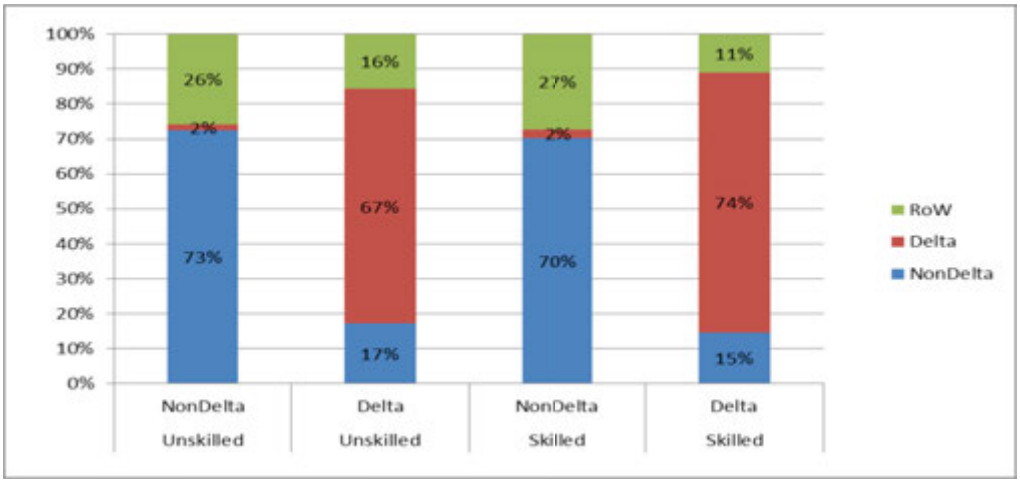



*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

Similarly, Figure 7b shows the distribution of employment by gender in major sectors across the regions. It is quite revealing that agriculture is the number one male employer across the different regions, whilst the service sector employs most females. Agriculture employs 45 percent of Non-delta males and 41 percent of delta males, whilst the service sector employs 48 percent of Non-delta females and 44 percent of delta females. The results also reveal that females' presence in the construction sector across regions is zilch, which may be due to the physically demanding nature of the sector or lack of interest. On the other hand, in the food industry across regions, more women than men are found in relative terms.

Significantly too, Figure 8a reveals that, of the embodied unskilled labour in the Non-delta, 73 percent works to satisfy the final demand of the Non-delta region of Ghana, 26 percent satisfies the RoW and 2 percent works to satisfy the final demand of the delta. This is quite similar to the distribution of male workers in the Non-delta as shown in Figure 7a. The distribution of unskilled labour also follows a similar pattern as the distribution of male workers in the delta and, the same holds true for the distribution of female workers in the delta and Non-delta spaces of Ghana. The results indicate that, regardless of skill set, labour produces mainly to satisfy domestic demand (within the Volta Delta) than for export (i.e. Non-delta and RoW).

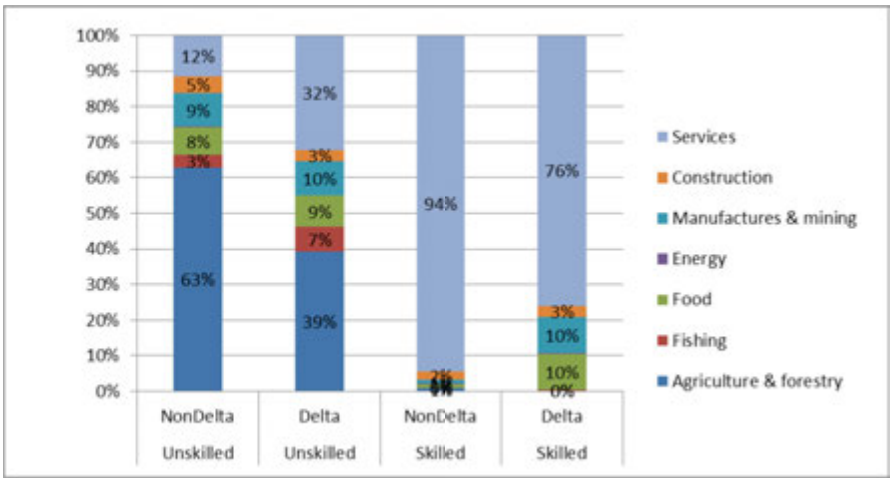
FIGURE 8A: EMBODIED LABOUR BY SKILL TYPE (GTAP CLASSIFICATIONS)




*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

The distribution of embodied labour by sector and skill type reveals that the agricultural sector in the Non-delta employs most of the unskilled labour, followed by manufacturing, then mining and food industry. While the agricultural sector employs most of the embodied unskilled workers in the Volta Delta, the service sector is the second largest employer, followed by manufacturing, mining and food industry. Interestingly, there is hardly any skilled labour in the agricultural sector across regions, with the service sector employing in excess of 90 percent of the embodied skilled labour in the Non-delta and 76 percent in the Delta, as shown in Figure 8b.

FIGURE 8B: EMBODIED LABOUR BY SECTOR AND SKILL TYPE (GTAP CLASSIFICATIONS)

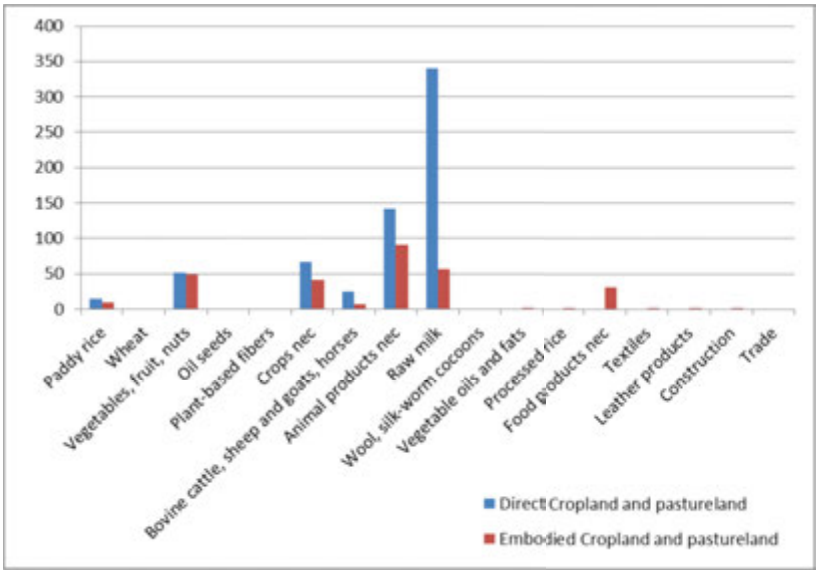



*Source:* Elaboration from the computations with the IO table and extensions of the Delta

### *5.3. Land, environmental embodiments and footprints*

This section focuses on land use and their impact on the environment. The results shown in Figure 9 relate to the sectoral analysis of labour by examining the land use and environmental impacts. The findings establish that, the direct agricultural land use is clearly dominated by pastureland, assigned to the production of raw milk, of animal products and others; then also of other crops and vegetables, fruits and nuts. This changes substantially when compared to the embodied agricultural land in the final demand of goods and services. In particular, it is observed that the embodied land use for animal products is particularly relevant, mostly occurring to satisfy final demand of the Non-delta and RoW (i.e. for exports). Furthermore, sectors not directly using agricultural land the most, such as food industries, have notable embodied (directly and indirectly) agricultural land levels.

FIGURE 9: DIRECT AND EMBODIED CROPLAND AND PASTURELAND (1000 HECTARES) OF THE DELTA




*Source:* Elaboration from the computations with the IO table and extensions of the Delta

Table 2 summarizes the direct uses of resources and environmental impacts (i.e. CO2 emissions) in production, embodied exports and imports and associated footprint (i.e. the embodied use or impact in the final demand of the households – Delta or Non-delta). According to these preliminary results, the Volta Delta is found to be a net importer of goods and services from the Non-delta region and the RoW.

The results in Table 3 summarize the embodied exports and imports between the Delta and the Don-delta spaces of Ghana. These results further confirm that, the Volta Delta is a net importer (embodied in higher levels of imported goods and services than exported) of agricultural produce and labour.

TABLE 2: SUMMARY OF IMPORT, EXPORT AND FOOTPRINTS

| | **Direct in production** | **Embodied exports (E)** | **Embodied imports (M)** | **Net trade (E-M)** | **Footprint** |
|---|---|---|---|---|---|
| Delta. Employment (1000 people) | 355 | 113 | 318 | -205 | 560 |
| Delta. Land (1000 hectares) | 670 | 222 | 612 | -390 | 281 |
| Delta. Energy (Mtoe) | 0.1 | 0.0 | 0.1 | -0.1 | 0.0 |
| Delta. CO2 (Mt CO2) | 0.1 | 0.0 | 0.1 | -0.1 | 0.0 |
| Non-Delta. Employment (1000 people) | 9,576 | 2,706 | 2,624 | 83 | 9,586 |
| Non-Delta. Land (1000 hectares) | 17,990 | 4,618 | 4,434 | 184 | 19,530 |
| Non-Delta. Energy (Mtoe) | 2 | 1 | 1 | 0 | 2 |
| Non-Delta. CO2 (Mt CO2) | 2 | 1 | 1 | 0 | 2 |

*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

TABLE 3: SUMMARY OF IMPORT, EXPORT AND FOOTPRINTS ONLY BETWEEN THE DELTA AREA & THE REST OF THE COUNTRY

| | **Direct in production** | **Embodied exports (E)** | **Embodied imports (M)** | **Net trade (E-M)** | **Footprint** |
|---|---|---|---|---|---|
| Delta. Employment (1000 people) | 355 | 60 | 187 | -127 | 560 |
| Delta. Land (1000 hectares) | 670 | 175 | 361 | -186 | 281 |
| Delta. Energy (Mtoe) | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Delta. CO2 (Mt CO2) | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Non-Delta. Employment (1000 people) | 9,576 | 187 | 60 | 127 | 9,586 |
| Non-Delta. Land (1000 hectares) | 17,990 | 361 | 175 | 186 | 19,530 |
| Non-Delta. Energy (Mtoe) | 2 | 0.0 | 0.0 | 0.0 | 2 |
| Non-Delta. CO2 (Mt CO2) | 2 | 0.0 | 0.0 | 0.0 | 2 |

*Source:* Elaboration from the computations with the IO table and extensions of the Delta and Rest of the country

## 6. Summary and conclusion

This paper has provided insights into the current state of the Volta Delta being studied under the *Deltas, vulnerability and Climate Change: Migration and Adaptation* (DECCMA) project. These insights focus on the socioeconomic and biophysical context as shown with the analyses of the prevailing economic sectors, employment and environmental embodiments and footprints. The input-output (IO) table and figures have shown interdependencies between the delta, the Non-delta region (i.e. the rest of the country) and in the rest of the world using the supply chain up to the final demand of goods and services.

From this paper, it could be concluded that, the Volta Delta economy is diverse; however, the agricultural sector remains dominant. Significantly too, the fishing sector of the Volta Delta sub-regional economy is relatively much larger than that of the rest of the country in percentage terms. Also, trade and transport activities, which often go unnoticed when highlighting important sectors of the delta such as small business trade as well as some manufacturing activities, were revealed to be relatively predominant in the Volta Delta economy compared to the situation in the rest of the country (Non-delta). These findings corroborate the results noted in a study by Gordon and Pulis (2010) on livelihood diversification and fishing communities in Ghana's Western Region.

Significantly too, the work of females satisfies directly and indirectly slightly less the final demands abroad (both in the Non-delta and in the RoW) than the work of males. The embodied work of women in the delta is most pronounced in services and manufacturing (including the food industry), while being relatively (with respect to the embodied works of their male counterparts) less pronounced in agriculture, energy, fishing and construction sectors. Also, compared to the females in the Non-delta, employment in services and agriculture is lower, but higher in manufacturing (including the food industry) and fishing. In addition, the work of the relatively skilled labour in the delta is embodied in the services (although this fact is even more marked in the Non-delta, in a much higher proportion than in India and Bangladesh being studied under the DECCMA Project), while being relatively less pronounced (with respect to the unskilled work) in agriculture and the fishing sectors. In the Non-delta, obviously except services, and the construction sector, any other sector has a smaller share of embodied labour than in the delta. Further, the results on land use show that agricultural land use is dominated by pastureland, notably in the part assigned to the production of raw milk. In particular, the embodied land use is also relevant in sectors not particularly having an important direct use such as food industries.

In conclusion, the results from this study show that, the Volta Delta is a net importer (embodied in goods and services from other regions, higher than in exports) of all the economic metrics studied including agricultural land use, employments, energy and $CO_2$ emissions. This is because, labour in the Delta whether by skill type or gender categories produces to satisfy domestic demands to a larger extent than consumptions in the Non-delta region (i.e. the rest of the country) and the rest of the world.

## Biographical notes

**Dr. Prince Osei-Wusu Adjei** holds a PhD in Geography and Rural Development. His research interest and experiences are on Decentralization and Local Governance, Rural Development, Livelihoods, Poverty and Gender Transition Studies. He is currently a Senior Researcher at the Nordic Africa Institute, Uppsala and a Senior Lecturer at the Department of Geography and Rural Development, KNUST, Kumasi, Ghana. Dr. Prince Adjei is the Ghana Lead for the Economics Work Package on the DECCMA Project.

**Dr. Ignacio Cazcarro** has PhD in Economics (University of Zaragoza, Spain). He worked 2 years as a post-doctoral research fellow (Department of Economics, RPI, Troy, NY, USA) participating in a National Science Foundation project. Ignacio is involved in economic analysis, construction of input-output tables and related models on the DECCMA Project.

**Dr. Inaki Arto** is a research fellow at Basque Centre for Climate Change, Spain. He has a PhD in Economics, He has occupied research positions at the Joint Research Centre of the European Commission (2010-2013) and at the University of the Basque Country (2001-2010). In the DECCMA project he contributes to the analysis of the economic impacts of climate change.

**Prof. Patrick Ofori-Danson** is a fisheries resource scientist with an interest in fisheries assessment and management. He was awarded the 2010 best teacher award for the sciences from the University of Ghana. As a member of the National Biodiversity Committee he has been involved in many policy decisions concerned with aquatic wildlife conservation issues to the Ghana government. Prof. Ofori-Danson works as Ghana team member on the Economics Work Package of the DECCMA Project.

**Dr. Joseph Asenso** is the Head of the Energy/Oil and Gas Unit of the Real Sector Division, Ministry of Finance, Ghana. He is responsible for the annual projection of Government's petroleum revenue, reporting on petroleum revenues

and general coordination of petroleum revenue-related activities. He also coordinates the national GDP projection exercise. Dr. Asenso works as Ghana team member for the Economics Work Package on the DECCMA Project

**Dr. Emmanuel Ekow Asmah** is a Senior Lecturer and Dean of the School of Economics, University of Cape Coast, Ghana. His broad interests are in the Drivers of Development in Africa mainly using household survey data and SAM-Based Computable General Equilibrium (CGE) Modelling Approaches. Dr. Asmah works as Ghana team member for the Economics Work Package on the DECCMA Project.

**Prof. Samuel Nii Ardey Codjoe** is a Professor of Population Studies and the Director of the Regional Institute for Population Studies (RIPS), University of Ghana, Legon. His research areas include population-environment nexus, migration, fertility, climate change/variability and its impact on urban and rural livelihoods. Prof. Samuel Codjoe is the PI for Ghana on the DECCMA Project.

**Prof. Kwasi Appeaning Addo** is an Associate Professor in the Department of Marine and Fisheries Sciences, University of Ghana. His research areas include coastal vulnerability index to sea level rise, coastal erosion, climate change impacts, and shoreline change monitoring. Prof. Kwasi Appeanning Addo is the Deputy PI for Ghana on the DECCMA Project.

**Samuel Amponsah** works as Principal Technologist at the Food Research Institute of Ghana. His research interests include fisheries assessment and coastal livelihoods. He is a research assistant for the Economics Work Package on the DECCMA Project.

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