DECCMA

Working Paper

Biophysical and Socioeconomic State of the Ganges-Brahmaputra-Meghna (GBM) Region of Bangladesh from the Perspectives of Gender and Spatial Relations

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Titles in this series are intended to share initial findings and lessons from research studies commissioned by the program. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the DECCMA project, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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Abstract:

This paper provides insights into the current socioeconomic and biophysical state of the Bengal Delta, or as we will call it here, Ganges-Brahmaputra-Meghna (GBM) Delta, in Bangladesh. Hybrid and non-survey methods, notably the Flegg Location Quotient (FLQ) method of regionalization and construction of tables, are used to develop environmentally extended input-output (IO) model for comparing the economic characteristics of the IBD region and the rest of the country. The main sources of data for doing the regionalization were Household Income and Expenditure Survey (HIES) 2010, Labour Force Survey (LFS), National Accounts, Bangladesh Input-Output Table (IOT) 2012, etc. Results from the study indicate that the fishing, trade and construction sectors are more predominant in the delta than in the non-delta region. On the other hand, the employment in the services, agriculture, and especially most industries, is higher in the rest of the country than in the delta. The work of females satisfies directly and indirectly more the final demand in the Rest of the World than the work of male, but that is not happen in the case of the final demand of the non-delta. The embodied employment of women in the delta is most present in agriculture, being this also a very marked result with respect to all other DECCMA deltas. Related to this, on the contrary the share of embodied employment of women in the delta is less present in services. Regarding the employment by skill, we may observe the dominance of “unskilled” in the delta embodied in the services, construction, and notably fishing, while being relatively less important in (interestingly) agriculture and manufactures and mining.

1 Introduction

This Working Paper is intended to gather some insights of the baseline, the present state of this delta, studied in the project DEltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA). Those insights have to do with the socioeconomic and biophysical context, with their relations and interdependencies with the economics through the supply chain up to the final demand of goods and services in the delta, in the country and in the Rest of the World (RW). In the following section 2 we present the context of the delta. Left in the Appendix 4 the Methodology, we place the focus on the insights for regionalization and construction of tables for the study of Deltaic areas, under the DECCMA. In particular, we firstly describe the general approach taken for all deltas, which consists in gathering socioeconomic and biophysical information to develop the Environmentally extended input-output (IO) tables and models, distinguishing the (DECCMA definition[1] of the) Delta and the Rest of the country (without the delta, which for simplicity we will call "Non-Delta", while we will call "Rest of the world" the vectors referred to the exports to and imports from of other countries). Then, we focus on the particularities of the construction of the input-output table of this delta. Section 3 shows the Results, consisting, firstly, on the comparison of Distribution of Value Added in the Delta and non-Delta. Secondly, the Labour and gender embodiments in the final consumption of goods and services, both within the country (delta and non-Delta) and in the Rest of the world. Thirdly, similarly we examine other environmental implications, such as the land and environmental embodiments and footprints. Section 4 presents the Conclusions and discussion.

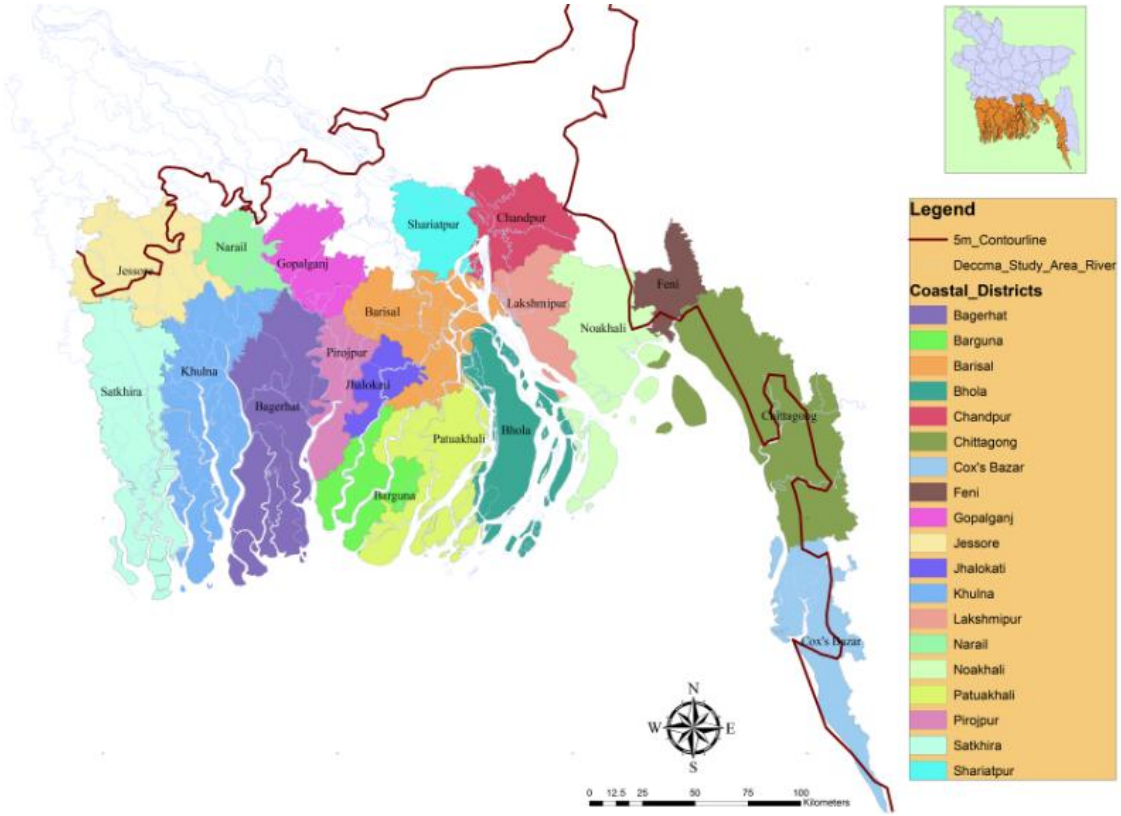
2 Context

The Ganges-Brahmaputra-Meghna (GBM) Basin spans across Bangladesh, Bhutan, Nepal, China and India, and presents one of the largest estuarine regions of the world, the Sundarbans delta. The area of the delta in Bangladesh comprises about 48 thousand km^2, being the area of Bangladesh outside the delta greater than 100 thousand km^2 (Population and Household Census, 2011). The GBM Delta lies mostly in the tropical wet climate zone. In general, maximum summer temperatures range between 38 °C and 41 °C (100.4 and 105.8 °F) and April is the hottest month in most parts of the country. January is the coolest month, when the average temperature for most of the country is 16–20 °C (61–68 °F) during the day and around 10 °C (50 °F) at night. Heavy rainfall is characteristic for Bangladesh. With the exception of the relatively dry western region of Rajshahi, most parts of the country receive at least 2,300 mm of rainfall per year. Because of its location just south of the foothills of the Himalayas, where monsoon winds turn west and northwest, the region of Sylhet in north-eastern Bangladesh receives the greatest average precipitation.

Regarding the hydrology, the average annual discharge of the three rivers into the Bay of Bengal is approximately 30,000 m3/s. During flood, the maximum discharge may exceed 80,000 m3/s whereas the minimum discharge may drop to some 6,000 m3/s. The major floods occur during the months from June through September. From the analysis of historical data of Bahadurabad in Jamuna River from 1956 to 2007, it has been found that severe flood may come more frequently in near future (IWM, 2007). Another threat may come from climate change on the flow of these three rivers. It has been found from the study that if rainfall will increase by 13% on the GBM basin and sea level will rise by 17 cm maximum flood level will increase by 37 cm in the Bahadurabad in Jamuna River which may create additional 13,000 m3/s flow in monsoon (IWM, 2007).

[1] 5 meter contour.

Figure 1: Physical Map of the GBM Bangladeshi Region

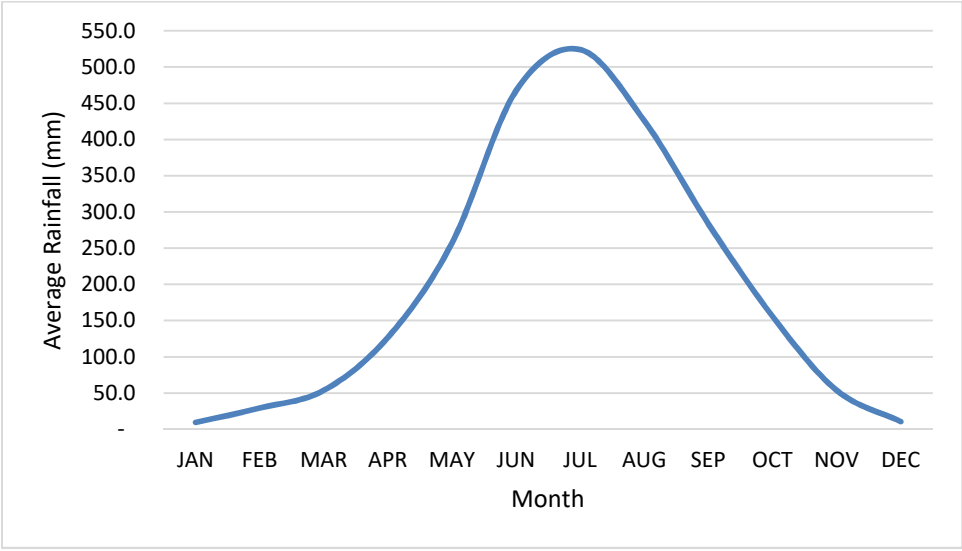


Note: DECCMA Study Area. Based on 5m contour line + coastal zone of Bangladesh. 19 districts.

Source: DECCMA WP2 team at Geodata (Southampton).

Average monthly rainfall patterns for GBM Bangladesh region have been shown in Figure 2. It clearly shows the dominant months in Bangladesh regarding the rainfall are May to September with peak in June-August (also known as the monsoon season in this part of the world).

Figure 2: Monthly Average Rainfall, GBM Bangladesh Region.



Source: Bangladesh Meteorological Department

Regarding the demography, some 156 million people live on a wide definition of the delta, despite risks

from floods caused by monsoons, heavy runoff, and tropical cyclones. Most of the GBM Delta has a population density of some 1,226 inhabitants per km² making it one of the most densely populated regions on earth. The annual growth rate is 1.292% (Alliance 2015). The most noticeable thing about male and female population is that the female population is almost as high as the male in the Delta. According to the Population and Household Census 2011, the DECCMA delta area has 18,677 thousand males and 19,221 thousand females (in the rest of the country, respectively 52,474 thousand males and 51,809 thousand females). The population density is 793 per km^2 for delta region where it is 1,041 per km^2 for the rest of the country.

Regarding the Expenditure Pattern, the average per capita monthly expenditures of Delta and Non-Delta have been considered. The Consumption Expenditure of the Delta is systematically smaller than in the non-Delta area of Bangladesh, except for the clothing, footwear and housing textiles. In the Delta Households it stands out the much smaller per capita expenditures than the non-delta, except for Oil and Fats (HIES 2015). The highest absolute differences which stand out, as shown in the last column significant at 1 % level of significance, are those of fruits, fish, food grains, meat and milk and diary, all above the 12% difference (HIES 2015).

Table 1: Demographic Profile (2011). Population by Gender (million people)

Region	Both sex (thousand)	Male (thousand)	Female (thousand)	Area (km2)	Density (per km2)
Non-delta	104,283	52,474	51,809	100,221	1,041
Delta	37,898	18,677	19,221	47,802	793

Source: Population & Household Census 2011

3 Methodology

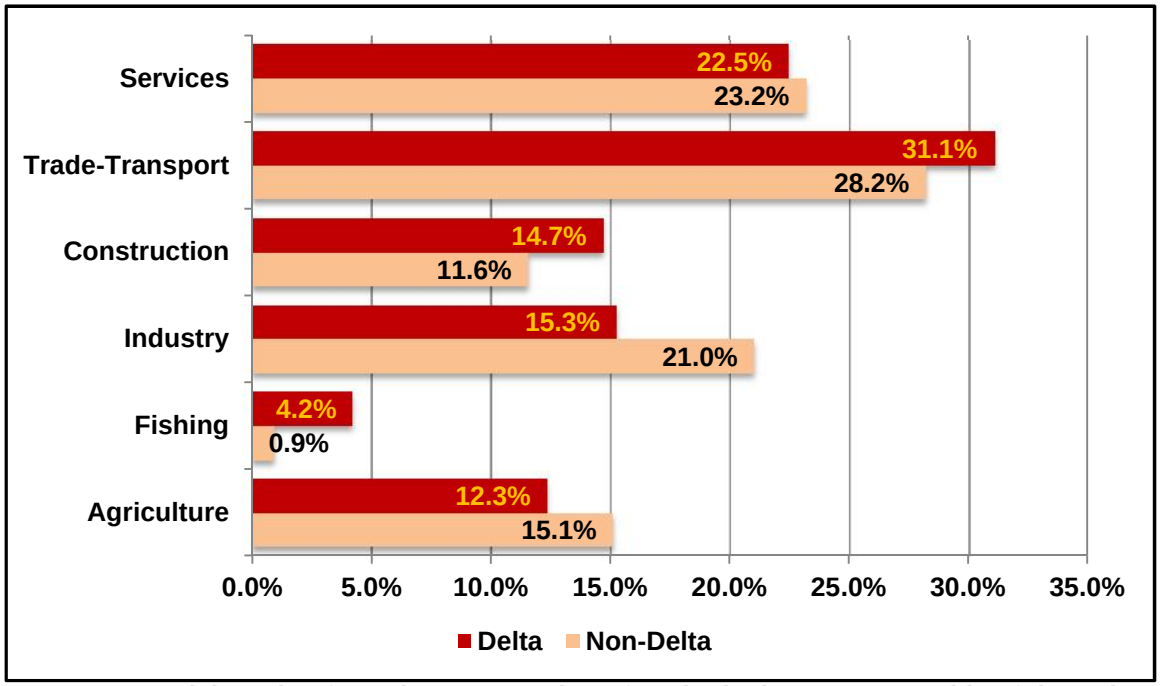
As described in detail in the Appendix 4, we place the focus on the insights for regionalization and construction of tables for the study of Deltaic areas, under the DECCMA. In particular, we firstly describe the general approach taken for all deltas, which consists in gathering socioeconomic and biophysical information to develop the Environmentally extended input-output (IO) tables and models, distinguishing the (DECCMA definition of the) Delta and the Rest of the country (without the delta, which for simplicity we will call “Non-Delta”, while we will call “Rest of the world” the vectors referred to the exports to and imports from of other countries). Then, we focus on the particularities of the construction of the input-output table of this delta, such as the hybrid methods used, departing from the non-survey method of regionalization and construction of tables, the Flegg Location Quotient (FLQ) method. This is used to develop an environmentally extended input-output (IO) model for comparing the economic characteristics of the GBM Delta region 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 results then shown in the following section have been obtained using the input-output tables and the models associated to them, in particular in combination with the socioeconomic and biophysical extensions/accounts.

4 Results

Distribution of Value Added

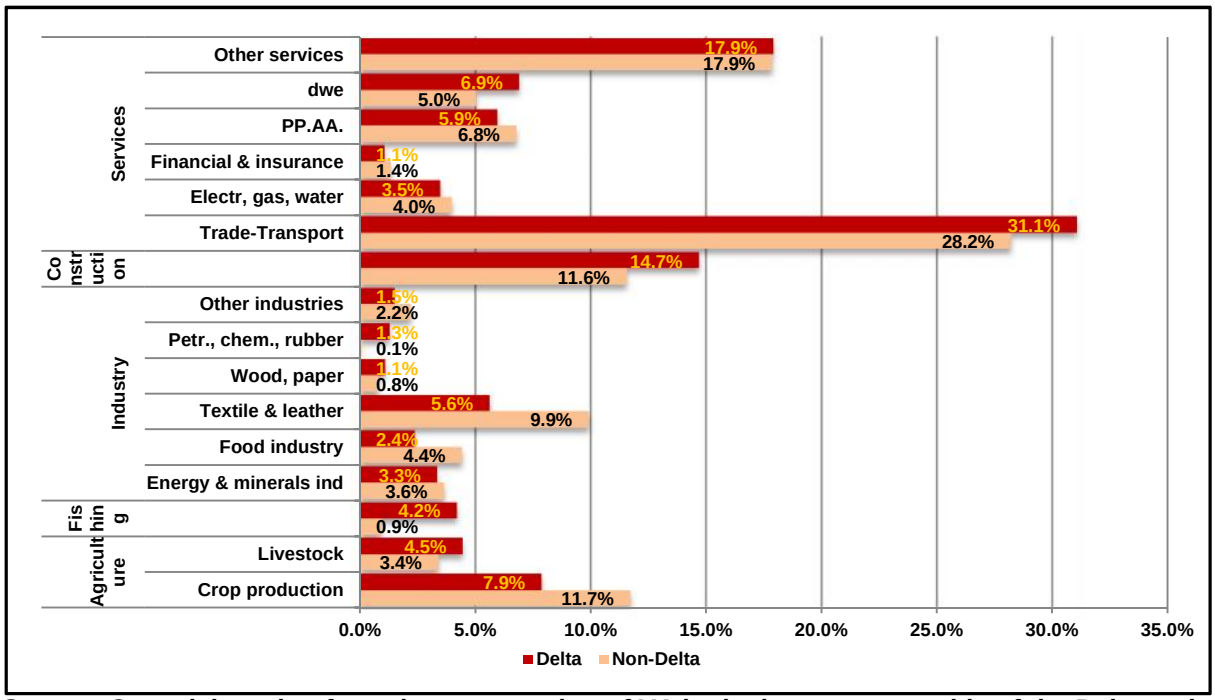
Following the methods of Appendix 4, Figure 3 and Figure 4 show the shares of value added (VA) of the main, respectively, 6 and 16 categories of sectors (from the aggregation of the 57 of GTAP 9).

Figure 3: Distribution of Value Added by main 6 categories for the deltas.



Source: Own elaboration from the computation of VA in the input-output table of the Delta and Rest of the country.

Figure 4: Distribution of Value Added by main 16 categories for the deltas.

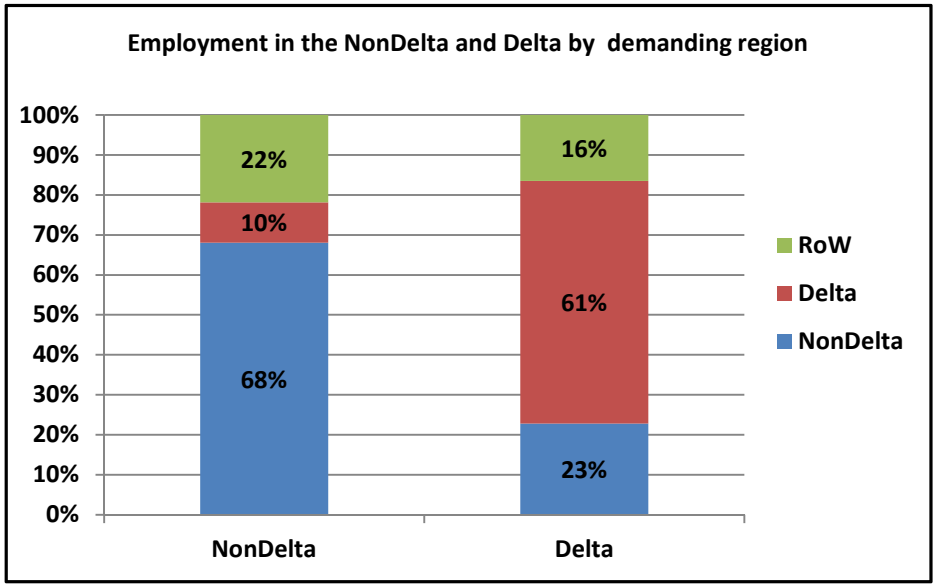


Source: Own elaboration from the computation of VA in the input-output table of the Delta and Rest of the country.

Figures 3 and 4 show the strong importance of the agriculture sector (interestingly not so relatively to the rest of the country), notably the fishing sector, which is relatively much bigger than in the rest of the country (4.2% vs. 0.8%). Also the construction sector, and trade and transport activities were revealed relatively more important in the delta than in the rest of the country (non-delta). On the other hand, the value added in the services, financial and insurance, in crop production and in some industries, notably Textile and leather, is higher in the rest of the country than in the delta.

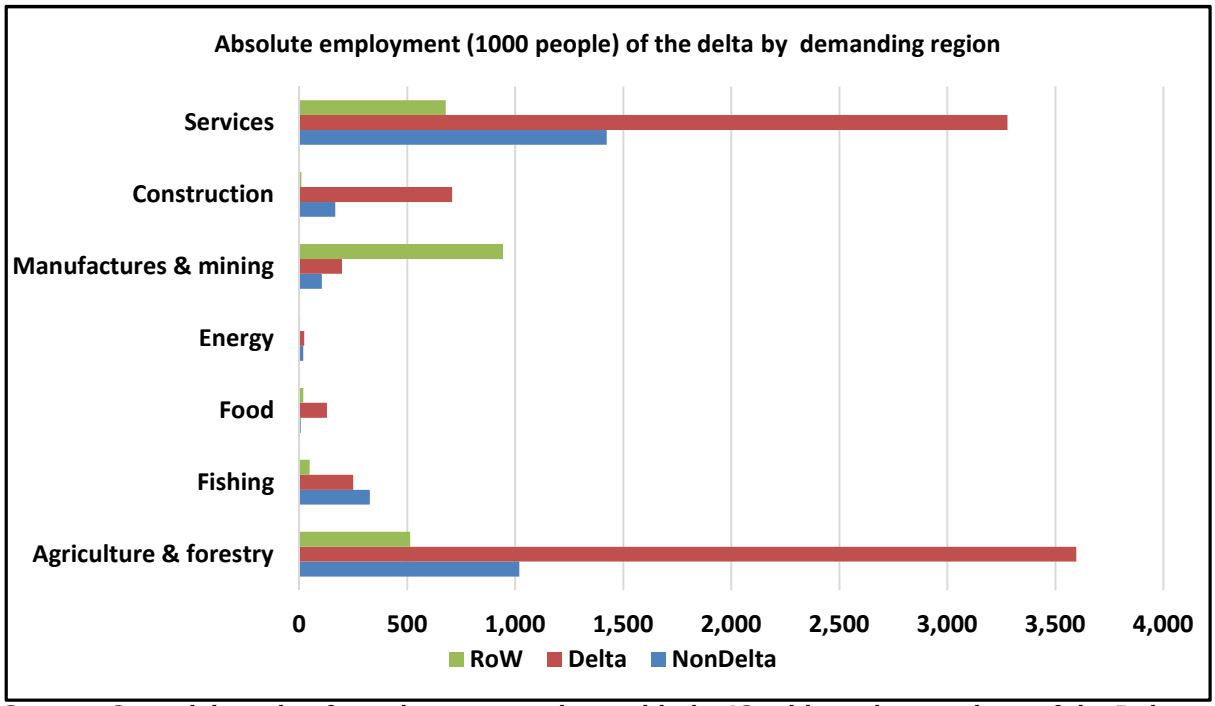
Labour and gender embodiments

Figure 5a: Employment of the delta by demanding region



Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Figure 5b: Employment of the delta by demanding region and sector

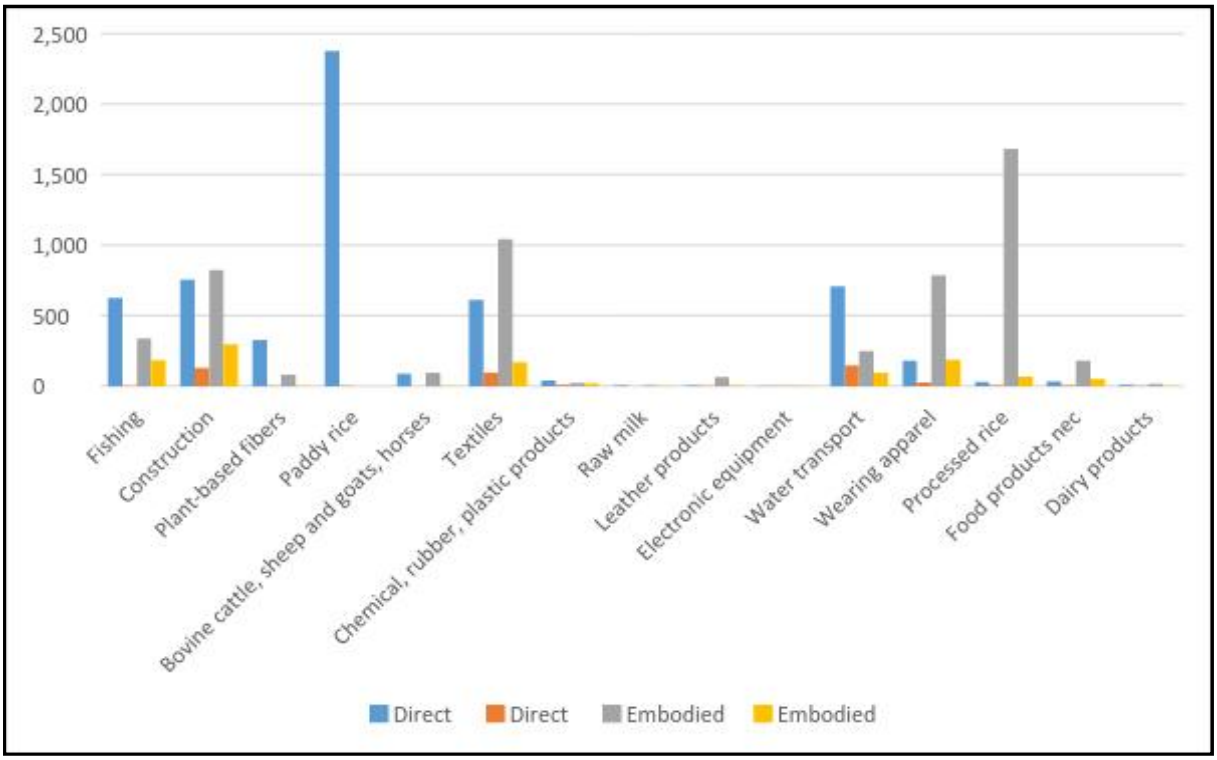


Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Compared to other deltas in DECCMA, the employment needed in the non-delta from the demand of goods and services in the delta is a higher share here in the GBM (more than 10%, as shown by the orange bar on the left hand side of Figure 5a), while also the employment triggered in the delta from the demand of the Rest of the World is a higher share (almost 20%, as shown by the grey bar on the right) than in other deltas. The employment in Bangladesh is estimated for 2011 in 54,864 thousand people; in the GBM delta, we get an employment of 13,473 thousand (13,473K) people. Behind the figure, we get that 17,452K people employed is needed to satisfy the goods and services demand in the delta. On the other hand, we observe on the right hand side how the employment in the delta has a non-negligible share (more than 20%) that is originated to satisfy the final demand of the non-delta.

Figure 5b shows the distribution by sector of that employment of the delta, showing that the employment in the delta has as main destination the satisfaction of the final demand within the delta itself (8,186,000 persons, more than 60%), notably in Services (3,278,000 persons), Agriculture and Forestry (3,597,000 persons), and Construction (708,000 persons, something that contrasts with other deltas, where normally it is more important the employment in Manufactures and mining). In the case of Services, an important number of workers (679,000 persons) satisfy the final demand in the Rest of the World, and also notably, Manufactures and mining (944,000 persons). Similarly for Services, 1,424,000 persons work to satisfy the final demand in the non-Delta, for Fishing (328,000 persons, superior to the employment to satisfy the final demand of the delta itself of 250,000 persons) and Agriculture (1,018,000 persons, but clearly inferior to the employment to satisfy the final demand of the delta itself). In this sense, compared to other deltas in DECCMA, the employment needed in delta driven by the own delta demands of agriculture and forestry are much more important here in the GBM, which relates to aspects such as the high self-sufficiency but also dependency of employment to the own demands, etc.

Figure 6: Direct and embodied labour of the delta by sector

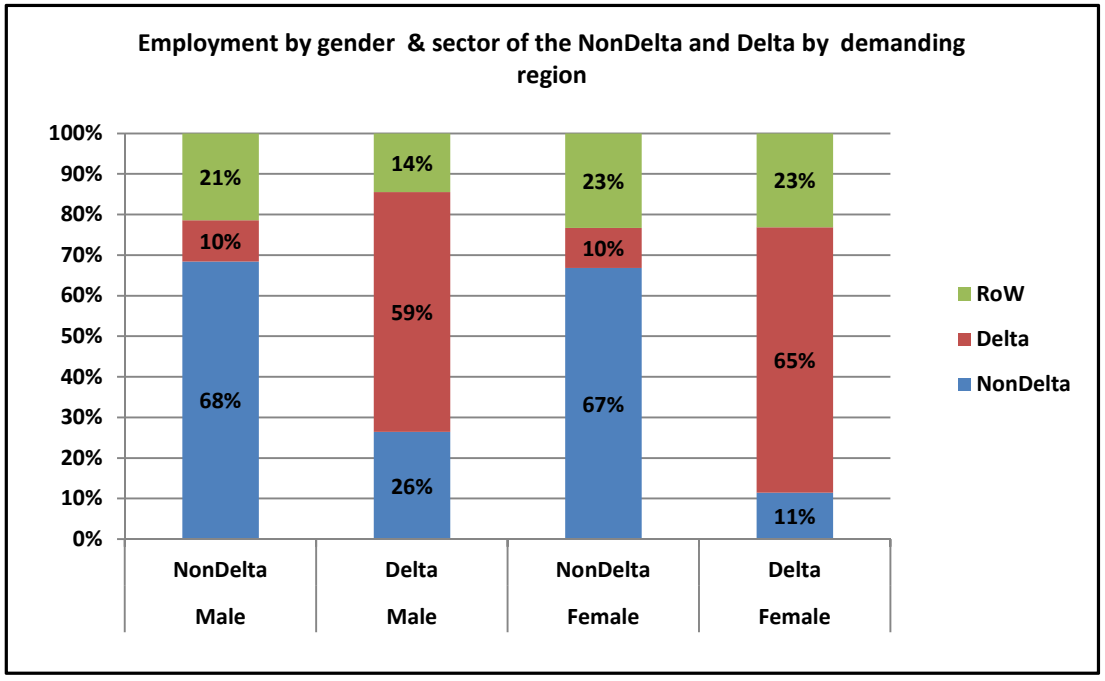


Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Figure 6 extends the insights obtained in Figure 5, with a sectoral and skill type (according to GTAP classification) detail. In particular, we may observe how is particularly relevant the embodied (directly and indirectly) employment in Processed rice and Textiles, mostly unskilled, on the construction sector.

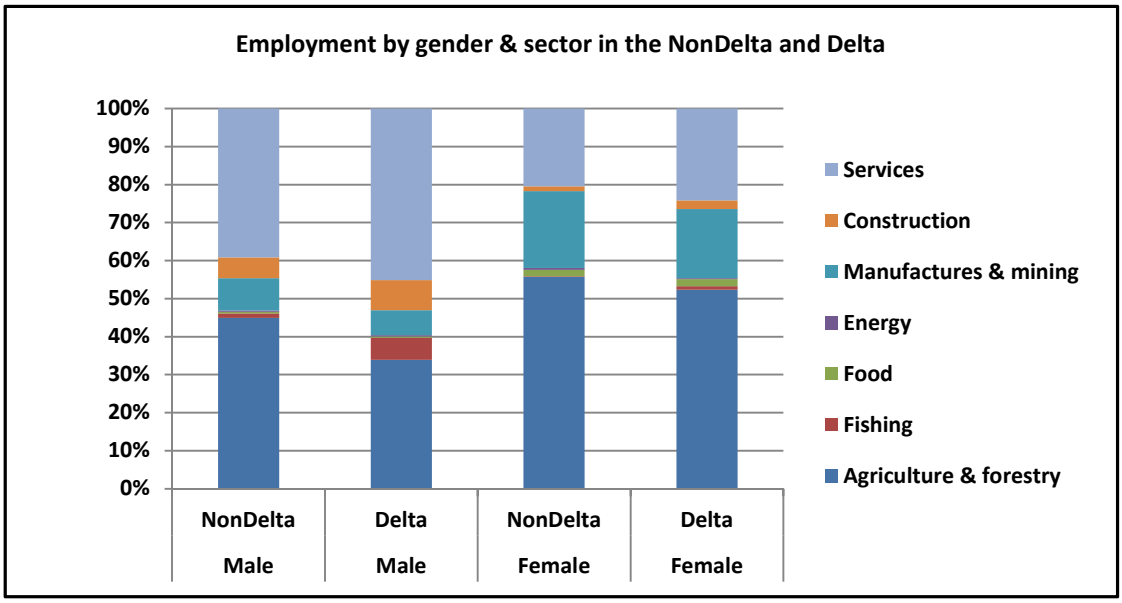
The fishing sector, mostly occurring to satisfy the (exports) final demand of the non-delta (also partly the Rest of the World), or wearing apparels, Plant-based fibers and especially paddy rice, although they have important (notably paddy rice) direct employment levels, they embody less employment in their final goods sold to final demand than others such as Food products.

Figure 7a: Employment by gender and sector of the NonDelta and Delta by demanding region



Source: Own 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

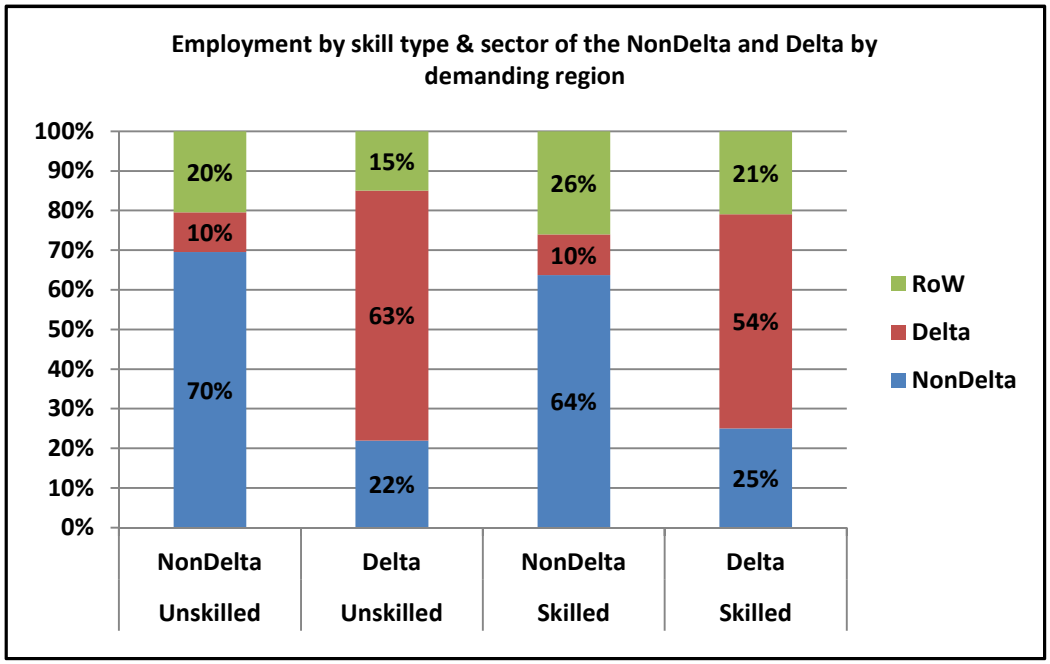


Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Figures 7a and 7b extend the insights obtained in Figures 5 and 6, by providing the gender detail of this

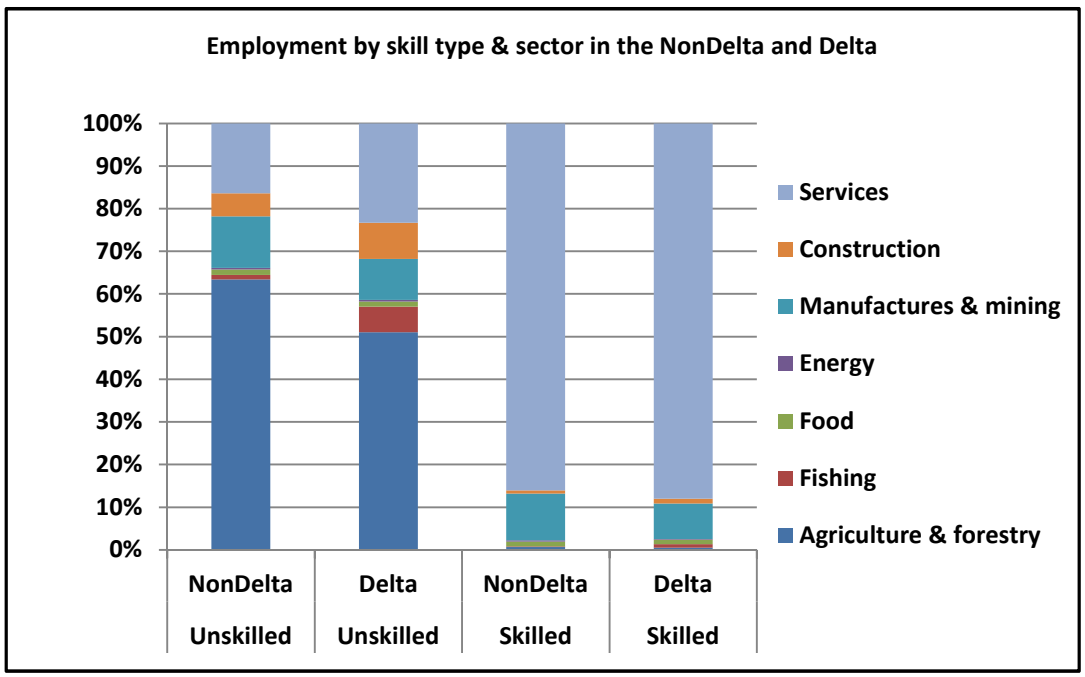
employment. We may observe in Figure 7a how the work of females satisfies directly and indirectly more the final demand in the Rest of the World than the work of male, however it is outstanding the very large proportion of female employment that serves to satisfy the demands of the delta itself. In Figure 7b we observe the embodied work of women in the delta occurs mostly in agriculture (some share that is not at all so high in other DECCMA deltas). Compared to the female of the non-delta though, this share is slightly smaller, while being higher in services and fishing.

Figure 8a: Embodied labour by sector and skill type (GTAP classifications)



Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Figure 8b: Embodied labour by sector and skill type (GTAP classifications)



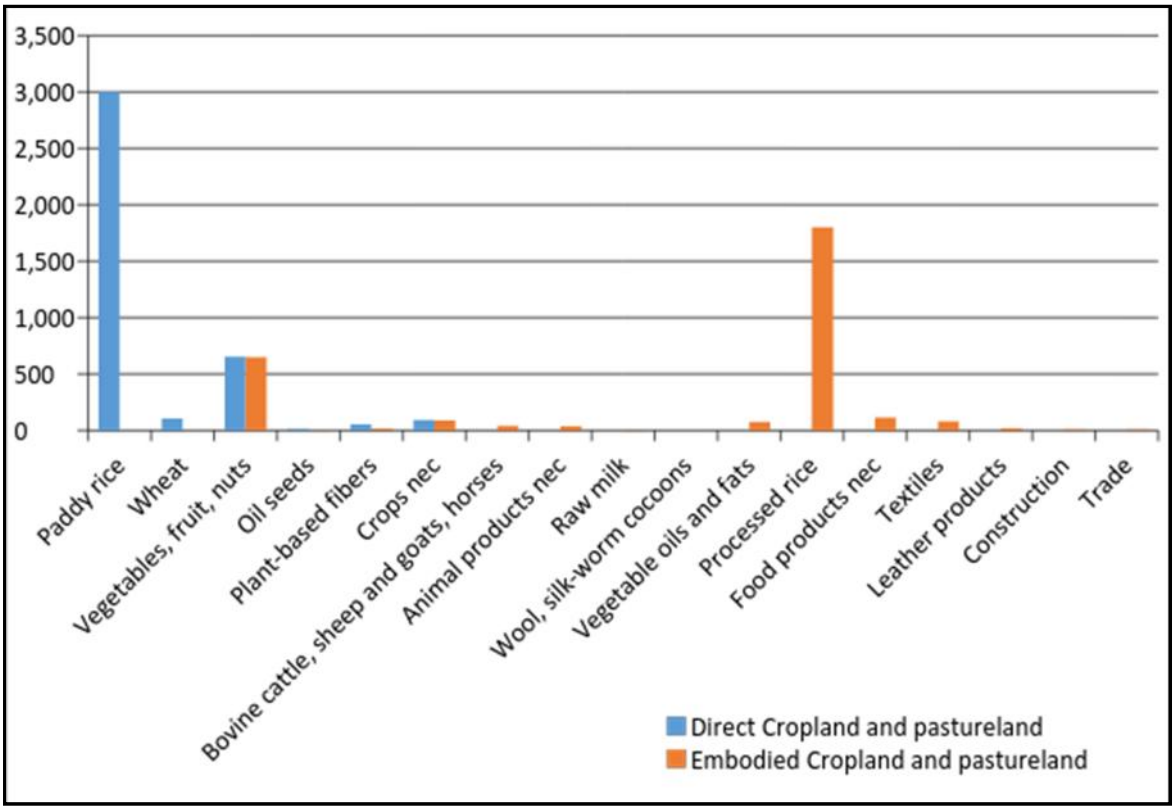
Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Figures 8a and 8b extend the insights obtained in Figures 5, 6 and 7, by providing the detail of this employment by skill type (according to the GTAP classifications). We may observe in Figure 8a how the skilled work satisfies directly and indirectly more the final in the Rest of the World (that is not the case for the non-delta, as in other DECCMA deltas) than the unskilled work. In Figure 8b we cannot distinguish much difference for the skilled employment; for the unskilled, we may observe the dominance of unskilled work in the delta embodied in the service, construction, and notably fishing, while being relatively less important in (interestingly) agriculture and manufactures and mining. In both the delta and the non-delta, it stands out the low share of skilled labour in the construction sector and manufactures and mining.

Land and environmental embodiments and footprints

The environmental extensions allows for the computation of many embodiments and footprints, which we illustrate, as an example, for the case of land use (in physical units) in Figure 9.

Figure 9: Direct and embodied Cropland and pasture land (1000 hectares) of the delta



Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Figure 9 examines, analogously to the analysis of labour in Figure 6, the embodiment of agricultural land of the delta in the demanding regions (delta; non-delta and Rest of the World). The direct agricultural land use is clearly dominated by paddy rice (3,000,000 hectares), but this change enormously when we look at the embodied agriculture land in the final demand of goods and services. In particular, we may observe how the embodied land uses in the vegetables; fruits and nuts are particularly relevant, mostly occurring to satisfy the (exports) final demand of the non-delta (also partly the RW). We also observe how sectors not directly using agricultural land the most, such as processed rice and food industry sectors, have notable embodied (directly and indirectly) agricultural land levels.

Table 2: Summary of import, export and footprints (land in 1000 hectares)

Footprint	Virtual Net trade	Embodied imports	Embodied exports	Direct in production	
17,452	-3,973	9,259	5,287	13,473	Delta. Employment (1000 people)
2,309	-1,685	2,877	1,192	3,994	Delta. Land (1000 hectares)
1.0	-0.2	0.8	0.6	1.2	Delta. Energy (Mtoe)
9.2	-2.2	7.5	5.3	11.4	Delta. CO2 (Mt CO2)
42,001	1,813	11,393	13,206	41,363	Non-Delta. Employment (1000 people)
18,285	188	2,170	2,358	14,990	Non-Delta. Land (1000 hectares)
3	0	1	1	3	Non-Delta. Energy (Mtoe)
24	2	4	5	22	Non-Delta. CO2 (Mt CO2)

Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

Table 2 summarizes the direct uses (of resources) or impacts (CO2 emissions) in production; embodied exports and imports (whose difference is the virtual net trade) and the footprint (the embodied use or impact in the final demand of the households of the area –delta or Rest of the country). The delta is net importer of every metric, embodied in goods and services bought from other regions (higher than in exports).

Table 3 summarizes the embodied exports and imports between the delta area and the Rest of the country. The delta results net importer of employment and land (higher than in exports), but net exporter energy and CO2 emissions embodied in goods and services sold to other regions.

Table 3: Summary of import, export and footprints only between the delta area & the Rest of the country

Net trade (E-M)	Embodied imports	Embodied exports	Direct in production	
-1,104	4,172	3,068	13,473	Delta. Employment (1000 people)
-628	1,643	1,015	3,994	Delta. Land (1000 hectares)
0.1	0.3	0.4	1	Delta. Energy (Mtoe)
1.7	2.3	4.0	11	Delta. CO2(Mt CO2)
1,104	3,068	4,172	41,363	Non-Delta. Employment (1000 people)
628	1,015	1,643	14,990	Non-Delta. Land (1000 hectares)
-0.1	0.4	0.3	3	Non-Delta. Energy (Mtoe)
-1.7	4.0	2.3	22	Non-Delta. CO2 (Mt CO2)

Source: Own elaboration from the computations with the IO table and extensions of the Delta and Rest of the country.

5 Conclusions and discussion

This Working Paper has tried to gather some insights of the baseline, the present state of this delta, studied in the project DEltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA). Those insights have to do with the socioeconomic and biophysical context, as we have shown with the analyses of employment and environmental embodiments and footprints. The input-output (IO) table and model have shown and used interdependencies through the supply chain up to the final demand of goods and services in the delta, in the country and in the Rest of the world.

Key results were the strong importance of the agriculture sector, notably the fishing sector, which is relatively much bigger than in the rest of the country (4.2% vs. 0.9%). Also the construction, and the trade and transport activities -which quite often go unnoticed when highlighting important sectors of the deltas, such as small business trade, etc.- were revealed relatively more important in the delta than in the rest of the country (non-delta). On the other hand, the employment in agriculture and manufactures and mining, is higher in the rest of the country than in the delta. The work of females satisfies directly and indirectly more the final demand in the Rest of the World than the work of male, but this is not

happen (contrary to what happens in several other DECCMA deltas) in the case of final demand in the non-delta. The embodied employment of women in the delta is most present in agriculture, being this also a very marked result with respect to all other DECCMA deltas. Related to this, on the contrary the share of embodied employment of women in the delta is less present in services. We cannot distinguish much difference for the skilled employment; for the unskilled, we may observe the dominance of unskilled work in the delta embodied in the service, construction, and notably fishing, while being relatively less important in (interestingly) agriculture and manufactures and mining. In both the delta and the non-delta, it stands out the low share of skilled labour in the construction sector and manufactures and mining.

The results on land use shows that although agricultural land use is clearly dominated by paddy rice (3,000,000 hectares), this changes enormously when we look at the embodied agriculture land in the final demand of goods and services. In particular, the embodied land use in the processed rice and other food products is particularly relevant, and also in sectors not directly using agricultural land the most, such as food industry and textile. All in all, the delta is net importer of several environmental metrics, embodied in goods and services bought from other regions (higher than in exports), but net exporter of energy and CO2 emissions to the non-delta.

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Appendices

Appendix 1: Codes

Labour: All other workers (previously classified as unskilled in GTAP 8), mgr: Managers and professionals, tec: Technicians and associate professionals, clk: Clerical support workers, srv: Service and sales workers.

Appendix 2: The Delta definition

Districts: Bagerhat, Barguna, Barisal, Bhola, Chandpur, Chittagong and Cox's Bazar, Feni, Gopalganj, Jessore, Jhalokati, Khulna, Lakhsmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira, Shariatpur.

Appendix 3: The Delta input-output table (aggregated to the main sectors) (Mio USD)

Total	Exports	Delta. FD	Non-Delta. FD	Delta. Rest (Construction and Services)	Delta. Industry	Delta. Agriculture	Non-Delta. Rest (Construction and Services)	Non-Delta. Industry	Non-Delta. Agriculture	
27,411	269	732	7,504	67	572	276	2,239	12,184	3,567	Non-Delta. Agriculture
77,233	18,889	3,524	21,037	1,049	2,357	156	6,532	21,754	1,935	Non-Delta. Industry
69,764	1,908	172	37,193	1,096	388	1,964	10,383	10,128	6,532	Non-Delta. Rest (Construction & Services)
11,243	357	3,344	2,794	986	2,203	626	4	752	177	Delta. Agriculture
22,677	6,950	5,548	1,886	1,884	5,322	437	172	266	213	Delta. Industry
30,674	428	16,620	5,239	3,388	2,344	1,937	222	278	219	Delta. Rest (Construction & Services)
0	-40,111	3,452	9,279	2,393	3,978	828	4,999	12,710	2,472	Imports
118,325	11,310	0	0	19,812	5,512	5,019	45,214	19,162	12,297	VA
357,328	**0**	**33,392**	**84,934**	**30,674**	**22,677**	**11,243**	**69,764**	**77,233**	**27,411**	**Total**

* Representation of the commercial account balance.

Appendix 4: Methodology

General approach of the (labour, gender, land, environmental) embodiments and footprints

The general approach taken for this Working Paper is an environmentally (the socioeconomics are already there) extended input-output model. This allows studying elements such as the labour, gender, land, environmental embodiments and footprints. To study the effects of alterations such as demand changes or climate change in these areas, require interdisciplinary knowledge and models. This one allows, for example with a classic model of Leontief demand(Leontief 1936, 1941, 1974; Miller and Blair 2009; Leontief 1970), to see how domestic demand (households, government, ...) and external

(exports) requires certain levels of labour and resources, which may well find availability limits (obviously generating growth limits, etc.) .

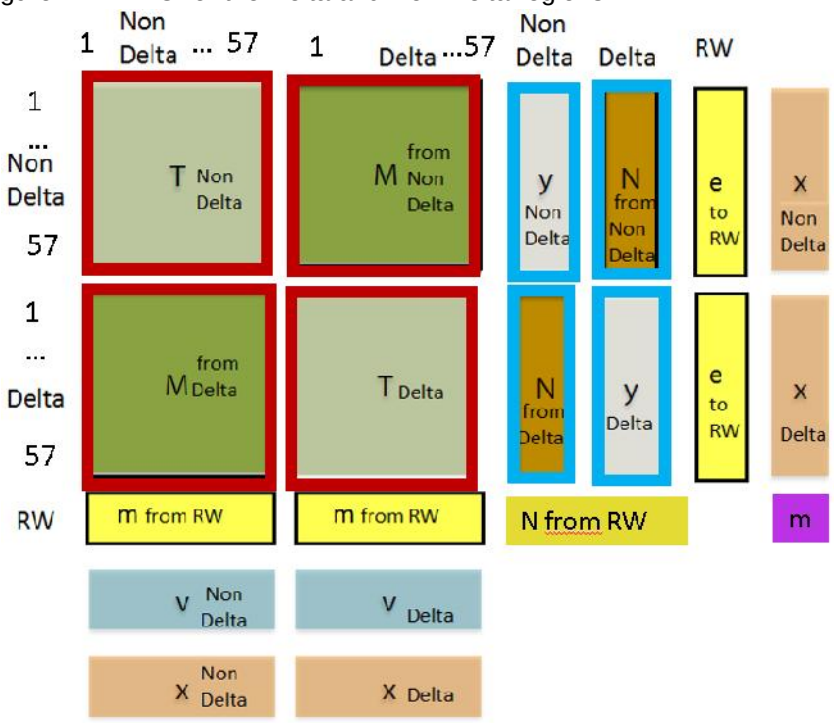
Developing regional tables and extensions of specific Deltaic areas, not matching the economic or political boundaries poses additional challenges, so we focus on.

- Exploration and description of the structure of the economies studied.
- Information directed towards the larger or most important elements of the economies studied and the inclusion of boundaries on some flows.
- The choice of the departure matrix of a surrounding country or region, with an economy similar to the one under consideration and the analysis of the problem of zero location.
- When having to use neighbouring or different scale IO data, identifying similarities rather than differences in regions economic structures.
- The (mis-)match between the political, economic and natural resources (in particular the hydrology defining the Deltas) boundaries and data.

Scheme of delta and non-delta input-output table and equations for the model

The scheme generates the multiregional input-output table for the delta, the rest of the country and the world, is shown in Figure ***A4*** , where the set of red squares representing transactions of intermediate goods **Z** = (z_{ij}) and set of blue boxes represent the matrix and **Y** is the vector of final demand.

Figure *A4*: MRIO for the Delta and Non-Delta regions.



Source: Adapted from (Kanemoto et al. 2011; Lenzen et al. 2013).

Where **T** are the Intermediate Domestic matrices, **M** the Intermediate import matrices, **y** the final demand excluding exports of final goods and services to the other region, **N** the final demand of exports (or imports respectively for each region) of goods and services from the other region in the same country, **e** are the column vectors of the exports of each of the regions to the Rest of the World (RW), **m** are the row vectors of the imports of each of the regions from the RW, **x** is total gross output, and **v** is the Value Added/Primary Input.

Departing from the basic model of Leontief: $\mathbf{x=Ax+y} \leftrightarrow \mathbf{x=(I-A)^{-1}y}$ (1)

Where x_i is the gross output of good i; **x** the vector of outputs of the economy; y_i the final demand of goods i; **Y**the matrix of final demand column vectors; $\mathbf{A} = \left(a_{ij} \right)$ the matrix of technical coefficients of the multiregional table indicated above, defined as $a_{ij} = x_{ij} / x_j$ $a_{ij}=z_{ij}/x_j$; finally,**L=(I-A)$^{-1}$**is the called Leontief inverse. Being **r**=(r_i) a vector of unitary coefficients of resource (or "input") or impact (employment, land, water, CO2, etc.) per unit of output, we obtain the multipliers, that is to say, the amount of resource directly or indirectly (embodied) per unit of final demand:

ω=r'(I-A)$^{-1}$ (2)

So when post-multiplying these values, the directly and indirectly "required" amounts (used) are obtained, verifying that:

r'x=r'(I-A)$^{-1}$y=ù'y (3)

All in all, this system allows for consistently (avoiding double-counting, etc.) measuring the direct and indirect social and environmental requirements for the goods and services supplied to the consumers.

Data and regionalization method for the construction of the input-output table

We use 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 (Narayanan et al. 2015). The GTAP database is aggregated toward a composite dataset that accounts for the specific regional requirements of our analysis. Regarding the data regionalization and update, we first choose the departure matrix of a country, surrounding or neighbouring region with an economy similar to the one under consideration, which in this case is the country table for 2011 of GTAP 9. We follow one of the most popular regionalization methods, variants of the Simple Location Method (SLQ) method[2], which have been recently developed and defended as superior to many other, the Flegg's Location Quotient (FLQ), see (Tohmo 2004; Flegg and Webber 1997, 2000; Flegg et al. 1995; Flegg and Tohmo 2013)(Kowalewski 2012). These works have shown the advantages of this method (e.g. improving the SLQs –only accounting for the selling sector- and Cross Industry Local Quotient, CILQ –considering the selling and purchasing sector, but useless for the main diagonals). In order to use this method, and regionalize to the delta the original national table and data of intermediate transactions, the employment and production totals by sector are the main data. Then, completing other parts of the table with "real" or specific delta data (e.g. the rows of employment, land use, etc., and columns of household consumption, government, exports, etc.), this "real" or ''superior'' data is added to make the best use of the available local data and avoid possible biases.

Particularities of the construction of the input-output table of this delta

The main information that allows doing the regionalization are the Bangladesh Statistical Year Book (BBS, 2014), Labour Force Survey of 2010 and 2013 (BBS-LFS, 2012), Bangladesh Bureau of Statistics, Alliance (2015), Household Income and Expenditure Survey (HIES, 2010), Bangladesh Planning Commission, data up to 2014, and Input-Output Table of Bangladesh (data up to 2012).

With these tables, for the GBM delta in Bangladesh, a RAS approach is performed to apportion the employment by category type (lab, mgr, tec, clk, srv, which are the unskilled and skilled categories of GTAP 9, see Appendix 1) and sector (each of the 57 sectors). On the one hand, we have the employment by district and gender (male/female) for the main 12 activities/sectors, which are split to 57 (the agricultural sector is disaggregated based on the particular info; while the rest of the sectors are split in the same proportion than the equivalent split of 12 to 57 at the national level of Bangladesh, which is given in the Labour force survey that the ILO gathers, (ILO 2015). At this national level, it exists the information of the employment by category type (lab, mgr, tec, clk, srv) by each of the 12 sectors

[2]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).

(ILO 2015). But for the districts we only have the total by category type (lab, mgr, tec, clk, srv), not knowing for which of the 12 districts it belongs. Finally, at the national level, some small corrections are applied to the employment data in order to obtain (as the ratio of the labour rows in GTAP and the employment of people) reasonable wages.

Other key data for the construction of the IO table, in particular the agricultural sector, are the agricultural land uses, production, prices, data of livestock, fisheries, etc.

Then the Social Accounting Matrix (SAM) is obtained from the regionalization of transfers and institutional (government, households, societies) interrelations, both at the national (already in GTAP 9) and delta levels. Data on the public sector has been obtained from National Account section of Bangladesh Bureau of Statistics.

The data on geography, climate and environment is obtained from several sources such as (IWM, 2005 and Sandilyan et al 2010), (IWM, 2007), (BRTC, 2008), (Dwivedi and Sharma, 2005), (IWM, 2008), IPCC, 2007), (World Bank, 1999 and Sandilyan et al 2010).

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Titles in this series are intended to share initial findings and lessons from research studies commissioned by the program. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the DECCMA project, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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