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Khalid Siddig
Samir Elagra
Harald Grethe
Amel Mubarak

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c/o Kerstin Oertel, Philippstr. 13, Haus 12, 10099 Berlin
phone: +(49)-30- 2093 46325, e-mail: k.oertel@agrar.hu-berlin.de
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A Post-Separation Social Accounting Matrix for the Sudan

Khalid Siddig[1, 2], Samir Elagra[3], Harald Grethe[1], Amel Mubarak[2]

[1] International Agricultural Trade and Development Group, Humboldt University of Berlin, Germany
[2] Departments of Agricultural Economics, Khartoum University, the Sudan
[3] Departments of Agricultural Economics, Sudan University of Science and Technology, the Sudan

Corresponding author: Khalid Siddig (khalid.siddig@hu-berlin.de)

Abstract

The 2012 SAM for the Sudan, with a special focus on agriculture, water and energy, is built using data from domestic sources in the Sudan including the Central Bureau of Statistics, the Ministry of Agriculture, the Ministry of Finance and Economic Planning and the Central Bank of Sudan besides other external sources. Major data sets used include the 2012 National Accounts and Trade Statistics of the CBS, the 53rd Annual Report of the Central Bank of the Sudan, the 2011 Labor Force Survey, the 2009 Household Income and Expenditure Survey, The 2009-2012 Agricultural Production Cost Survey and the 2005 Industrial Survey. Data from external sources are used to complement national sources. These sources include IMF studies on government finances, FAO reports and data on agriculture and ILO reports on labor. The SAM distinguishes between agricultural activities based on the modes of irrigation, energy based on its major sources and water based on modes of production and types of uses. Land is divided into irrigated and non-irrigated, while natural water resources are added in a separate account. Households are categorized by state, location (rural and urban) and income quintiles. Labor accounts are differentiated based on location (rural and urban), skill level and gender.

Keywords: Sudan, Social Accounting Matrix, agriculture, water, energy

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We were kept motivated throughout this work, despite the disappointments of lacking good data, by researchers from all over the world being interested in a SAM for the Sudan and looking forward to pursuing SAM-based analyses on the Sudan. In this regard, we would like to thank Dr. Hans Lofgren of the World Bank, Dr. Clemens Breisinger of IFPRI and Dr. Badri Gopalakrishnan and Dr. Angel Aguiar of Purdue University. We appreciate your patience and we look forward to seeing your published work based on this SAM.

We strived to make this SAM as reliable as possible using the best and most recent available data sets for the country. Any mistakes or weaknesses of the resulting SAM, however, should be attributed to the authors and not to those providing the data sets.

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List of acronyms

CBoS	Central Bank of the Sudan
CBS	Central Bureau of Statistic of the Sudan
CGE	Computable General Equilibrium
FAO	Food and Agricultural Organization of the United Nations
IEA	International Energy Agency
ILO	International Labor Office, Geneva, Switzerland
IMF	International Monetary Fund, Washington, D.C., USA
MFEP	Ministry of Finance and Economic Planning, the Sudan
MHRDL	Ministry of Human Resources Development and Labor, the Sudan
MoAF	Ministry of Agriculture and Forestry, the Sudan
MoI	Ministry of Industry
SAM	Social Accounting Matrix

1 Introduction

A Social Accounting Matrix (SAM) is a tabular form of presenting economic data of a country, a region or any administrative unit (village or group of countries) in which payments of each account (outgoings) are reported in the column, while receipts (incomings) are reported in the row. The SAM can be summed up to reflect the macro-economic aggregates (Macro-SAM) or disaggregated to represent individual accounts such as the commodity accounts wheat or cheese (Micro-SAM). From an accounting perspective, the SAM applies the double entry bookkeeping system where each entry is interpreted with respect to its column and its row and must balance, i.e. column and row totals equal. Hence a SAM is a squared matrix with equal row and column dimension (Pyatt and Round, 1985).

When the data of a country in a particular year is organized in the form of SAM, it becomes a snapshot of that particular country's economy reflecting the entire structure of the economy and its interdependencies. This being said, the SAM is a static snapshot of the economy and any dynamics in the economy need a model in order to be depicted. Therefore, a SAM presents core data on which different modeling frameworks depend, the most common of which is Computable General Equilibrium (CGE) Models and SAM Multiplier Models.

This paper describes the development of a 2012 SAM for the Sudan. The importance of this SAM evolves from it being the first to be developed for the country after the division of Sudan into two countries, namely, the Republic of Sudan and the Republic of South Sudan. In fact, the Sudan (before and after the division of July 2011), has suffered for long the lack of such databases due to many factors, one of which being the devastating sanctions imposed on it by the United Nations (UN), the United States (USA) and the European Union. The capacity for developing comprehensive data sets at the Central Bureau of Statistics (CBS) has been stagnating for long combined with limited interest of international research and funding institutions. Therefore, building a detailed SAM for the Sudan has been and still is a challenging task.

The CBS does neither publish Input/Output Tables (IOT) nor Supply and Use Tables (SUT), both being building bricks for a detailed SAM. The last IOT developed by the CBS was for the year 1961 (Siddig, 2009). Nevertheless, there were several attempts by individual researchers to develop SAMs and IOTs for the Sudan such as Elbushra (2007) and Siddig (2009). The current economic developments after the separation including the attribution of the majority of the country's oil to South Sudan, the associated austerity measures applied to cope with the consequences and the Nile water issues arising after the departure of Mubarak in Egypt are all tempting research issues that require a detailed SAM for analysis.

This paper describes the data used and the transformations followed to compile various data sets together with published other work in order to build the 2012 SAM for the Sudan. Accordingly, the paper presents the various data sources used to build the SAM in the following section. Section 3, describes the general structure, the accounts included in the Micro-SAM and the special characteristics of the SAM. Section 4, presents the estimation

procedures followed to build the SAM starting with the development of a 2012 Macro-SAM, the reconciliation of the different data sets (e.g. National Accounts, trade, household survey and labor force survey) and the generation of a balanced Micro-SAM. Section 5 depicts the Sudanese economy in 2012 as reflected by the SAM with detailed tabular and graphical presentation of the different macro and microeconomic agents of the economy and their interdependencies. Finally, Section 6 concludes and suggests ways to potential data improvements.

2 Data sources of the 2012 SAM

The Central Bureau of Statistics (CBS) of the Sudan is the main source from which this SAM draws its data. The data obtained from the CBS can be generally categorized into three major components, namely, National Accounts data, trade data, and household income and expenditure survey data.

The National Accounts data covers the following aggregates: 1) Gross Domestic Product (GDP) at value added with data on 39 production activities covering output, intermediate demand, compensation of employees, depreciation, operating surplus and net indirect taxes; 2) GDP at market prices; 3) Composition of GDP by different economic activities; 4) National income; 5) Composition of GDP by type of expenditure to include government final consumption expenditure, private final consumption expenditure, gross fixed capital formation, changes in stocks, exports of goods and services and imports of goods and services; and 5) aggregates of government revenues and expenditures.

Trade data of the CBS comprises imports and exports by chapter, division and commodity according to the Harmonized System of the United Nations. Trade data was aggregated to the level of the SAM accounts.

The latest available household income and expenditure survey was that of 2009, which was published in 2010 (CBS, 2010). The survey was conducted in all states and comprises a sample of about 8000 households. It provides data on the income sources and income generated from them as well as expenditures aggregated to 24 food and nonfood items.[1]

Other local data sources include the Central Bank of the Sudan (CBoS), the Ministry of Human Resources Development and Labor (MHRDL), the Ministry of Agriculture, the Sudan Taxation Chamber (STC), Sudan Customs and the Ministry of Finance and National Economy (MFNE).

[1] No access to raw data of the survey was granted.

The CBOS's 53rd Annual Report is used to complement sectoral data on production and trade as well as on the government and external accounts (CBoS, 2014). The Sudan Labor Force Survey for 2011 is used to incorporate details on employment by sector, gender and skill level for employees in the different states of the country (MHRDL, 2013). Information on taxes and customs rates is obtained from the Sudan Taxation Chamber (STC, 2013) and Sudan Customs (2012), respectively. Data on crop production is obtained from the General Administration of Agricultural Statistics of the Ministry of Agriculture and Forestry (MOAF, 2015).

Besides national data sources, data from several international organizations such as the World Bank (2016), the FAO (2015, 2004), the International Monetary Fund (IMF), The International Energy Agency (IEA, 2016) and the International Labor Organization (ILO, 2009) as well as other published research are used to complete missing data.

3 Structure and contents of the SAM

The general structure of the 2012 SAM for the Sudan can be explained using the descriptive Macro-SAM shown in Table 1. The Macro-SAM incorporates 13 aggregated accounts in addition to the "Total" of all the accounts. Columns are identified by "letters", while "numbers" are assigned to the rows in order to facilitate referring to individual cells in the table. This implies that cell (1A) corresponds to the total intermediate input in Table 1, where the column account (A) pays the row account (1). In the Macro-SAM, the cell 1A contains one number which is the total intermediate demand by all activities in the economy. In the Micro-SAM, this will correspond to the entire intermediate input matrix in which all activities pay the commodities they use in the production process.

Starting with the first row of the table (row account 1), there are 6 transactions in this row in addition to the total, all representing the commodity demand in the country. These demand categories include intermediate consumption (1A), household consumption (1H), government consumption (1G), investment demand (1I), changes in stocks (1D) and exports (1W). In the Micro-SAM, 1A will be a matrix, which dimensions are the individual activity accounts in the columns and the individual commodity accounts in the rows. Transaction 1H will be a matrix where the individual households' accounts are located in the columns and individual commodity accounts in the rows. The remaining 4 transitions of commodity demand will be represented in the Micro-SAM by four vectors, where the rows are individual commodity accounts and the columns are government, investment, stock changes and export demand.

The second row, account (2), is for the domestic supply of commodities, which is only occupied by transaction 2C in the Macro-SAM, while in the Micro-SAM it will be a matrix where the individual commodity accounts are in the rows and the individual activity accounts are in the columns.

Table 1: General description of the Macro-SAM for the Sudan

	Outgoings / Incomings	C	A	L	K	N	H	E	G	IX	DX	I	D	W	T
		Commodities	**Activities**	**Labor**	**Capital**	**Land**	**Households**	**Enterprises**	**Government**	**Indirect tax**	**Direct tax**	**Invest-ment**	**Stock change**	**Rest of world**	**Total**
1	**Commodities**		intermediate input				Private consumption + NPISH		Government consumption			GFCF	Stock changes	Exports	Total demand
2	**Activities**	Domestic output													Total output
3	**Labor**		Compensation of employees											Labor income	Compensation of employees
4	**Capital**		Operating surplus + depreciation											Property income	Capital income
5	**Land**		Rent												Land income
6	**Households**			Labor income	Dividends and rents	Rent			Transfers to households					Private transfers	Private income
7	**Enterprises**				Capital income - depreciation				Capital expenditure						Corporate income
8	**Government**							Proceeds to SOENT + property income and loyalties		Indirect taxes	Direct taxes			Grants	Government revenue
9	**Indirect tax**	Indirect taxes	Net taxes on production												Net indirect tax
10	**Direct tax**						Income tax	Corporate tax							Direct tax
11	**Savings**				Depreciation		Private Savings	Enterprises savings	Government deficit					Foreign saving	Total savings
12	**Stock change**											Stock change			Stock change
13	**Rest of world**	Imports		Labor payments	Property income		Transfer		Transfer						Foreign exchange outflow
14	**Total**	Total commodity supply	Gross output	Labor costs	Capital expenditure	Land expenditure	Private expenditure	Corporate expenditure	Government expenditure	Net indirect tax	Direct tax	Total invest-ment	Stock change	Foreign exchange inflow	

Source: Authors.

Compensation of employees from domestic activities (3A) and from abroad (3W) constitutes the total income to labor in the third row account. In the Micro-SAM, transaction 3A is a matrix where the individual activity accounts are in the columns and the individual labor categories are in the rows. Similarly, returns to capital from domestic activities (4A), which include the operating surplus and depreciation (payment to land by activities is also included here) together with returns to capital from abroad (4W), constitute total returns to capital. In the Micro-SAM, transaction 4A is a matrix where the individual activity accounts are located in the columns and capital and land in two rows.

Income to households is depicted in row account (6), which consists of five different sources, namely, income from employment (6L), dividends (6K), rents (6N), government transfers (6G) and foreign transfers (6W). In the Micro-SAM, transaction 6L is a matrix where the individual labor categories are located in the columns and individual households' accounts in the rows. The remaining transactions of row 6 in the Micro-SAM are five vertical vectors representing capital, land, government, and foreign transfers in the columns paying to the individual household accounts in the rows.

Income to Enterprises is depicted in row account (7), which includes capital incomes (net of depreciation, 7K) and government payments to state-owned companies. These transactions are exactly reflected in the Micro-SAM as the SAM includes only one enterprise account.

Government income is reported in row account (8) and it consists of four different sources: proceeds to state-owned enterprises (SOENT) and property income and royalties, both combined in transaction (8E); net indirect taxes (8IX); direct taxes (personal income and property taxes combined in transaction 8Dx); and grants from the rest of the world (8W). These transactions are preserved in the Micro-SAM as the SAM includes only one government and one "rest of the world" account, while similarly direct and indirect taxes are represented by only two accounts.

Income of the indirect tax account (9) consists of indirect taxes on commodities (9C) and indirect taxes (subsidies) on production activities (9A). In the Micro-SAM, transaction (9C) is represented by a matrix where the individual commodity accounts are located in the columns and individual indirect tax accounts (sales tax, imports subsidy and tariffs) in the rows. Transaction (9A) is represented in the Micro-SAM by a vector, whose columns are the individual activity accounts all paying their indirect tax (subsidy = negative tax) to the production subsidy account in the row.

Direct tax, which is included in row account (10), receives income from households (personal income tax, transaction 10H) and enterprises (property income tax, 10E). The personal income tax appears in the Micro-SAM as a vector where columns are the different household categories. The transaction on property income tax is identical in the Macro and Micro-SAMs.

The savings row account (11) has five different income entries, namely, depreciation (11K), private savings (11H), firms' savings (11E), government savings (11G) and foreign savings (11W). All these transactions appear again in the Micro-SAM except the private savings,

which is represented by a row vector where columns are the individual household categories. Row account (12) reports the income to stock changes, which was paid by the investment account (12I). This transaction is preserved in the Micro-SAM; however, the column account (expenditure) of the stock changes is a column vector in the Micro-SAM where rows are the individual commodity accounts.

Finally, the rest of the world row account (13) receives income from imported commodities (13C), payments to foreign workers in the domestic labor market (13L), returns to foreign capital (13K), households' transfers abroad (13H) and government transfers to the rest of the world (13G). In the Micro-SAM, the imports payment abroad, the labor payment abroad and households' transfers abroad are row vectors in which columns are the individual commodity accounts, labor categories and households' groups, respectively. The remaining transactions by the capital and government accounts paid to the rest of the world are identical in the Micro and Micro-SAMs.

The "Total" account is the summation of all income sources for each row account and all expenditures for each column account. As the SAM applies the double entry bookkeeping method in accounting, transactions of the SAM from a row point of view (incomings) can also be looked at from the perspective of the columns (outgoings). Finally, the "Total" entry for each identical account in the row and column must equal.

4 The estimation of the SAM

This section highlights the procedure followed to develop a detailed Micro-SAM for the Sudan. It starts by describing a numerical Macro-SAM that is based on the National Accounts (CBS, 2015a) and is used to control the submatrices of the Micro-SAM. Afterwards, it describes the steps followed for each submatrix of the SAM and how all these together are estimated to produce the final Micro-SAM.

4.1 A numerical Macro-SAM for 2012

A numerical Macro-SAM for the Sudan is developed as a general guidance and control to the submatrices of the Micro-SAM. The first row account (1) reflects the payments made by the different demanders of commodities in the Sudan in 2012 as reported in the National Accounts data of the CBS (CBS, 2015a). The same commodity account in the column reflects the total supply of commodity that consists of domestic output and imports. The only addition here to the CBS (2015a) data is the net indirect taxes payment, which is adjusted to accommodate the production subsidy that is obtained from MFNP (2015) and an external source (IMF, 2014).[2] Hence, activity payments to production factors are based on CBS (2015a), while the production subsidy is calculated based on MFNP (2015) and IMF (2014).

[2] Indirect taxes are reported as "Net indirect taxes" by the CBS, but no indication of production subsidies is made. Hence, the value of indirect taxes is raised to accommodate the SDG 1280 million of the subsidy.

The allocation of total production factors' income to households and enterprises is based on all labor and land incomes accruing to households (6L and 6N), depreciation accruing to the savings account (11K), and the remaining capital income going to enterprises (7K) and households (dividends and rents, 6K); taking into account the households income sources of the households income and expenditure survey of the CBS (CBS, 2010). The payments of labor and capital to the rest of the world are based on CBS (2015a).

All the remaining accounts in the Macro-SAM are based on the national accounts statistics of the CBS except the savings of different institutions. The government deficit is adopted from MFNP (2015), while the savings of households and enterprises are calculated as residuals, but with strict consideration of the total savings 'value' of the National Accounts (CBS, 2015a).

Table 2: A numerical 2012 Macro-SAM for the Sudan (SDG billion)[3]

	Incomings \ Outgoings	C	A	L	K	N	H	E	G	IX	DX	I	D	W	T
		Commodity	Activity	Labor	Capital	Land	Households	Enterprises	Government	Indirect tax	Direct tax	Investment	Stock changes	World	Total
1	Commodity		90.6				174.8		14.6			31.4	6.2	18.0	335.6
2	Activity	299.0													299.0
3	Labor		69.5											0.0	69.5
4	Capital		137.5											0.0	137.6
5	Land		1.4												1.4
6	Households			69.4	4.3	1.4		94.8	8.0					4.3	182.2
8	Enterprises				107.9				9.0						116.9
7	Government							8.3		8.8	5.8			0.9	23.9
9	Indirect tax	8.8													8.8
10	Direct tax						1.1	4.8							5.8
11	Savings				14.7		4.1	9.0	-7.7					17.5	37.7
12	Stock changes											6.2			6.2
13	World	27.8		0.0	10.7		2.2		0.1						40.8
14	Total	335.6	299.0	69.5	137.6	1.4	182.2	116.9	23.9	8.8	5.8	37.7	6.2	40.8	

Source: Authors.

[3] Average (official) exchange rate in 2012 was: US$1= 3.701 SDGs. Average (official) exchange rate for January- March 2016 is: US$1= 6.3 SDGs.

4.2 Developing the Micro-SAM for 2012

Based on the numerical Macro-SAM for the Sudan, individual submatrices were developed and the entire Micro-SAM is brought together in one template and subjected to an estimation process (Robinson and McDonald, 2006). The following subsections describe the main processes performed in each one of the submatrices.

4.2.1 Production and value-added

Production data are provided by the CBS (2015a) for 39 activities of which 7 are agricultural activities. Agricultural crops are represented by four accounts including irrigated, traditional rainfed, mechanized rainfed crops and other crops (minor crops and agricultural byproducts). The remaining agricultural activities are livestock, forest and fishing. For these activities, total intermediate demand, total operating surplus, depreciation, total compensation of employees and net indirect taxes are provided for 2012 by CBS (2015a).

The procedure applied here is that the column vectors for all these indicators are prepared. For the activity outputs, no further processing is undertaken at this level of aggregation (39 activities). However, later after the estimation of 39 activity-accounts SAM, output is further disaggregated based on data for individual commodity outputs provided by the CBS but with slightly lower quality and consistency.

The final Micro-SAM provides data on the output of 71 activity accounts including 36 agricultural activities. The full list of the activity and commodity accounts of the Micro-SAM and their correspondence to the activities of CBS (2015a) is shown in Appendix 1.

4.2.2 Intermediate demand

Moving from the vector of total intermediate demand by activity provided by the CBS (2015a) to a detailed matrix of intermediate demand that involves 71 activity accounts and 58 commodity account was particularly difficult in the absence of an input output table, which was the case for this SAM for the Sudan. Three major sources of data are used to produce an input/output matrix for the Sudan. First, MoAF (2014) provides data on the costs of production for different agricultural crops in selected states and farming systems for selected years ranging from 2009 to 2012. Second, MoI (2005) provides production cost for the industrial sector in the Sudan for the year 2005. Third, CBS (2015c) provides data on intermediate demand by activity for selected service sectors.[4]

The first data source is characterized by a lack of consistency with the CBS and international sectors classifications and therefore, it shows missing data points. The second source, although detailed, is for 2005 and renders our matrix tied to a more than 15 year old input/output structure of the industrial sector. Accordingly, external sources, published and

[4] A full list of the activity and commodity accounts of the final detailed SAM is provided in Appendix 3, Appendix 4, Appendix 5 and Appendix 6.

unpublished reports, unpublished data and experts' judgments are used to complete missing data and adjust implausible inputs.

4.2.3 Households

The main source of the household data is the comprehensive household income and expenditure survey that is conducted for the year 2009 and published in 2010 (CBS, 2010). The survey, which provides a processed data set (no access to raw data was granted), is based on a sample of slightly more than 7500 households and covers the 15 northern states of the former Sudan. It is used to build household submatrices. In addition, the 2007 household expenditure survey (CBS, 2008) is also used to further disaggregate the commodities.[5]

In addition to the state-dimension, household data considers two other dimensions as well, namely, location (urban and rural) and income (five income quintiles). The expenditure survey comprises 24 commodities, 14 of which being food items. After processing household expenditure for these 24 commodities, CBS (2008) is used to disaggregate the 24 consumption items to those of the SAM (i.e. 58 commodities). The concordance between the SAM accounts, 2009 survey and 2007 survey is governed by the Classification of Individual Consumption According to Purpose (COICOP) system of commodity classification. It is to be noted that only the shares of the detailed consumption items are taken from the 2007 survey and applied to that of 2009.

No tax information is provided in the household survey; hence, the national level value of personal tax reported by CBS (2015a) is applied to the different household groups based on their total income.

The survey provides data on 18 different sources of income, which are mapped to the corresponding SAM accounts, namely, land, labor, capital, enterprises, government and the rest of the world according to the correspondence shown in Appendix 2. The savings of different households are calculated as residuals.

4.2.4 Production factors

The CBS (2015a) provides data on total compensation of employees by each of the 39 activities reported within the National Accounts data. The task here was to disaggregate this column vector of payments from activities to labor to sub-columns that represent the different labor categories. The main source of data used for this is the labor force survey for 2011, which is conducted by the Ministry of Human Resource Development and Labor (MHRDL, 2013). The labor force survey provides data on the level of employment and unemployment in the Sudan together with the number of employed persons and wages by sector. For most of the indicators, data is provided by state, area (rural and urban) and gender (male and female). There are 21 sectors covered in the survey.

[5] The 2007's household survey provides 6-digit data for three income-categories of households, namely, high, middle and low income.

One challenge we encountered is that despite the different dimensions considered in the data, (e.g. state, location, gender and skill levels) theses dimensions are not consistently connected for a particular labor group.

The first step was to group the nine skill groups of the survey to three in order not to have empty or less representative groups at some branches of the labor force tree. The International Labor Organization's (ILO) International Standard Classification of Occupations Structure, Group Definitions and Correspondence Tables (ILO, 2012) is used to group the original 9 skill categories of the labor force survey into three, namely, skilled, semi-skilled and unskilled as shown in Table 3.

Table 3: The mapping of ISCO-08 major groups to skill levels

Skill levels		ISCO-08 major labor groups	
No.	**Description**	**No.**	**Description**
1	Skilled labor	1	Managers
		2	Professionals
		3	Technicians and associate professionals
2	Semi-skilled labor	4	Clerical support workers
		5	Services and sales workers
		6	Craft and related trades workers
		7	Skilled agricultural , forestry and fisheries
		8	Plant and machine operators, and assemblers
3	Unskilled labor	9	Elementary occupation

Source: ILO (2012, pp 14).

Afterwards, the 21 sectors of the labor force survey are mapped to the 39 sectors of the production activities based on the level of production in each sector. Finally, the gender and location (rural and urban) dimensions are incorporated based on the number of employed persons and wages in the labor force survey (MHRDL, 2013).

4.2.5 International trade

The best quality of data that one can obtain from the CBS in the Sudan is the international trade data. Data on imported and exported commodities according to eight digits of the Harmonized System are provided for 2012 by CBS (2015b). Guided by the concordance between the international Standard Industrial Classification (ISIC), according to which

production data is classified and the harmonized system of trade data, the 8 digits trade data are mapped to the SAM commodity accounts.[6]

4.2.6 Taxes

This SAM includes six different tax accounts, namely, two subsidy accounts (production subsidy and imports subsidy), three other indirect tax accounts (sales tax, stamps-and-fees and import tariffs), and one account for direct taxes. Data on direct tax and indirect taxes (subsidies excluded) are provided by CBS (2015a) on revenue for the government (i.e. no breakdown by sector). However, the same source provides a column of data among the Gross Domestic Product (GDP) at factor cost data, which is the "net indirect tax". Additional aggregate tax data are also obtained from Sudan Taxation Chamber (2014).

For the breakdown of the sales tax and stamps-and-fees, the "net indirect tax" payments by the different sectors are applied to distribute their total values over the different commodities. For import tariffs the custom data of Sudan Customs (2012), which classify all imported commodities according the harmonized system and provide tariff data for each, are used to distribute to total import tariff amount over the different imported commodities. Direct taxes on households are distributed based on total incomes of the different groups of households as no tax data are provided in the household survey.

Data on subsidies as government expenditure on wheat and petroleum products are provided by MFEP (2011; 2015). The assumption is made to allocate all wheat subsidies on the imported wheat, based on evidence that only imported wheat is subsidized by providing foreign exchanges at a lower exchange rate to importing companies. Subsidies on petroleum products are divided according to IMF (2014) to a subsidy on production, which is paid to the crude and refined petroleum sectors of the SAM, and a subsidy on imports, which is paid to imported refined petroleum.

[6] A full list of the activity and commodity accounts of the final detailed SAM is provided in Appendix 3, Appendix 4, Appendix 5 and Appendix 6.

5 Special extensions in the water and energy sectors of the SAM

A couple of specific extensions (disaggregation) are included in the SAM to allow addressing some pressing research issues related to the water, energy and food nexus in the Sudan and the region of east Africa. More specifically, the extensions include: 1) expanding the water activity and commodity to three activities and commodities, namely, pipe, porterage and irrigation water; 2) expanding the electricity activity to distinguish between hydropower and oil based power and based on this, electricity is represented by one commodity in the SAM produced by two different activities; 3) introducing an additional energy account (commodity and activity) for biofuel and waste being a major energy source in the Sudan (IEA, 2016); 4) distinguishing irrigated land from non-irrigated land; and 5) introducing a natural water resource production factor.[7] The following subsections cover the procedures followed as well as the data and assumptions applied to accommodate these extensions.

5.1 Water

The water activity and commodity of the SAM are disaggregated to include pipe, porterage and irrigation water. The porterage water in the Sudan is especially important and quite common in urban peripheries and rural areas. Therefore, including it will allow addressing issues of further developing water infrastructure in urban and rural areas of the country. The irrigation water is also very important especially in a country where the majority of households lives by and depends on the Nile water. This became even more important after the raising Nile-water concerns among the Nile-basin countries in recent years.

5.1.1 Why does water disaggregation matter?

The disaggregation of water activities is justified by different cost structures of producing each type of these three water commodities. For instance, pipe water is pumped from the Nile or from ground water, subjected to different treatments and pumped again in the water pipelines that supply it to industries and municipalities. Porterage water, in contrast, could be collected from the Nile directly, from wells, from pipe water or from water harvesting excavation and transported using animals or vehicles to final consumers. A more detailed comparison between these cost structures is shown in Table 4.

The three water commodities are also different as they represent different qualities of water with the pipe water presumably being of a higher quality. Therefore, the disaggregation at both activity and commodity levels is plausible.

[7] A full list of the activity and commodity accounts of the final detailed SAM is provided in Appendix 3, Appendix 4, Appendix 5 and Appendix 6.

Table 4: Comparison between the three water types in the Sudan

Types of water	Source	Production costs	Distribution means	Consumers
Pipe	• Nile • Ground water	• Pumping • Purification • Distribution • Maintenance	• Pipeline	• Municipalities • Industries
Porterage	• Nile • Ground water • Pipe water • Irrigation water • Excavation water	• Collection (fees apply if the source is pipe water) • Transportation • Animal feeding • Maintenance	• Animal drown carts • Vehicles	• Households • Construction sector
Irrigation	• Nile • Ground water	• Pumping • Fees for dam-based water • Maintenances of channels and pipelines	• Irrigation channels • Irrigation pipelines	• Agriculture

Source: Authors own elaboration.

As shown in Table 4, the irrigation water is either Nile water or groundwater, with the majority being Nile water. Pipe water is mostly pumped from the Nile, purified and distributed. But there are also some pipe water projects based on ground water sources. Porterage water is a distribution service commodity, which uses pipe, irrigation or excavation water and is consumed by the construction sector and households. It has both quality and price differences from the other two types of water, which becomes especially important if water-use modeling is considered using the SAM. Porterage water is sometimes supplied in city peripheries where pipe-water networks are established but supply is not stable. In such a case, porterage water would be more expensive than pipe water despite the possibility of being of lower quality; but normally, the porterage water is cheaper.

Data for output, intermediate input, value added and taxes for both pipe and porterage waters are supplied by the CBS (2015a). Within the intermediate demand category, all sectors are assumed to consume pipe water except agriculture and construction sectors where for the former only irrigation water is consumed, while for the latter porterage water is consumed together with pipe water.

Because no data are available from CBS (2015a) on irrigation water, irrigation water output is assumed equal to the total cost of water production reported in the agricultural survey of MoAF (2014). Hence, total water output in the country (the three water types combined) is increased by the amount paid for irrigation water and therefore, the shares of pipe, porterage and irrigation waters in the total water supply is 35%, 43% and 22%, respectively. These shares do not reflect the quantity, but the value of water output. FAO (2015) shows that water

withdrawal by sector is 92.2%, 3.5% and 0.3% for agriculture, municipalities and industry, respectively.

5.1.2 Cost structures of the different water activities

Intermediate input costs of the pipe water are assumed to preserve the structure of CBS (2015c), which provides costs of production for the aggregate water commodity. For breaking down the total intermediate costs of the porterage water to its different commodity components, actual examples of the service costs in Khartoum and Gezira states are considered by consulting local experts. The resulting cost structure for porterage water is shown in Table 5.

Table 5: Cost structure of supplying porterage water by activity

Intermediate cost item	Share (%)	Corresponding sector in SAM
The cost of water (only pipe water incurs costs)	32.5	Pipe water
The cost of animal feed	28.6	Other crops
Maintenance of the cart	19.5	Road transports
Rent of the drawing animal	19.5	Livestock

Source: Authors' assumptions based on local experts' estimation.

Valuing the costs of supplying and consuming irrigation water is known to be complex[8], especially in case of a high variety of irrigation methods. In the Sudan, the main irrigation method by irrigated area is flood irrigation from dams built on the river Nile. However, that is not the only source especially if the cost of water in total agricultural production value is considered.

The costs of dam-based irrigation water are mainly labor that operate the dam in addition to capital cost, maintenance of dams as well as irrigation channels and fuel (if any). For the pumped irrigation water, major costs will be operational, such as fuel, maintenance of machinery including spare parts, maintenance of irrigation channels, labor and capital. In this SAM, irrigation water is represented by one activity that combines pumped and dam-based water due to the lack of data to separate them. Therefore, the cost structure of this activity is a mixture of pumped and dam-based water. Based on expert guesses and own assumptions, the cost structure of the irrigation-water activity is assumed to include labor (58%), natural water resource (14%), capital (6%), construction (6%), maintenance (6%), fuel (3%), electricity (3%) and water (3%). In addition, small cost shares of less than 1% are devoted to trade, business, finance and pipeline services.

[8] For comprehensive coverage and a literature survey on valuing irrigation water, refer to FAO (2004).

5.2 Electricity

Total electricity supply in the Sudan in 2012 was 9436 Gigawatt hours (GWh), which is either hydropower-based or oil-based. Hydropower-based electricity supply was 6619 GWh (70% of total supply) in 2012 while oil-based power supply was 2817 GWh (30%) in the same year (IEA, 2015). Similar shares are reported by the World Bank (2015). Therefore, this SAM distinguishes the two sources of electricity represented by separate activities. Acknowledging that both hydropower-based and oil-based electricity run in the same network; the different electricity commodities are not distinguished in the SAM.

5.2.1 Division of activities and cost structures

To divide the electricity activity into hydro-based and oil-based, the challenge is to come up with reasonable cost structures for each activity. For this SAM, we followed the approach of Peters (2015) in which he disaggregated the energy sector of the GTAP 9 database to 11 different activities and commodities according to technologies. For the cost structure of the Hydro-based electricity, his data for Ethiopia is chosen, a country where more than 99% of electricity is generated from hydropower (World Bank, 2015) and in the same region. No significant differences in cost structures among different countries are shown for hydro-electricity generation in the database, particularly in comparison to Nigeria, Brazil and Egypt, showing similar cost structures.

For the oil-based electricity, the cost structure is based on that of Cameroon (Peters, 2015) because Cameroon is the only country in Africa besides the Sudan where electricity is mainly supplied by hydro-power and oil sources with considerable contributions from each, 72% and 20%, respectively (World Bank, 2015). The final cost structures of the two activities are shown in Table 6.

Table 6: Cost structures of the two electricity activities*

	Intermediate inputs			Primary factors and taxes	
	Hydro-electricity	Oil-electricity		Hydro-electricity	Oil-electricity
Textile, wearing apparel and leather	0.2	0	Labor	4.2	2.2
Wood and wood products including furniture	0	1.0	Capital	86.6	0.4
Paper and paper products printing and publishing	0	0.1			
Chemicals including petroleum and plastic products	0	94.7			
Non-metallic industries	0	0.4			
Basic metal industries	0	0.1	Subsidy	-7.7	-7.7
Fabricated metal products machinery and equipment	2.2	1.6			
Other manufacturing industries	0	0.5			
Electricity	11.6	4.4			
Water	0.0	0.1			
Building and construction	0.5	0.1			
Commerce	0	1.0			
Air transport	0.1	0.1			
Road transport	0.4	0			
Water transport	0.1	0			
Communication	0	0.1			
Finance	0.2	0			
Insurance	0	0			
Business services	1.4	0.9			
Social recreational and related community services	0.1	0			
Total (intermediate input + primary factors + taxes)				100.0	100.0

Source: Authors based on Peters (2015) and World Bank (2015).

5.2.2 Introduction of a biofuel and waste account

CBS data do not account for a very important energy source in the Sudan particularly in rural areas and communities, which is the use of forestry products, crop residuals and animal waste as energy sources for cooking, heating and construction[9]. The IEA (2015) provides 2012 data on production (375582 Tera Joule-TJ) and consumption. Consumption is divided between residential use (111675 TJ, 62%), industry (28554 TJ, 16%), and commercial and public services (38791 TJ, 22%).

In order to add a sector for that in the SAM, a conversion of the energy units into monetary units is needed. In the energy balance for the Sudan of the IEA (2015), energy from all sources is presented in thousand tonnes of oil equivalent (ktoe), which allows us to come up with the production value of biofuel being SDG 8.83 billion.[10]

The residential consumption of biofuel is assumed to be mainly (90%) allocated to rural households with 10% consumed by urban households[11]. For both urban and rural households the electricity consumption shares of the survey CBS (2010) are used. The industry consumption of biofuel is assumed to be limited to the food sector (70%), own use (20%)[12] and other manufacturing (10%). In services, the use of biofuel is assumed to be confined to the construction sector.

Primary factors account for 77.5% of the cost structure of the biofuel activity, acknowledging that the absolute majority of this activity is performed by labor (75%) and intermediate demand (22.5%) (Table 7). Agricultural crop residuals and livestock wastes contribute to the cost of the biofuel activity because they are widely used in rural areas of the Sudan for cooking, producing charcoal and producing building bricks.

9 It is widely common in the Sudan that animal, crop and forestry products and residuals are used to heat building bricks that are produced from clay soil muds mixed with animal residuals.

10 Production value for electricity is provided by CBS (2015a) and energy units of hydropower, oils-based electricity and biofuel are all provided by the IEA (2015). This information is used to derive monetary values for biofuel. Note that the biofuel-based energy is assumed to be 50% cheaper than other energy sources.

11 Certain types of woods are consumed (burnt) in urban as well as rural Sudan as a perfume and body softener for females and as medications.

12 Some biofuel goes into the process of producing other biofuel (e.g. firewood is an input for producing charcoal).

Table 7: Cost structure of the biofuel activity

Intermediate input costs	Share (%)	Costs of primary production factors	Share (%)
Total payment to intermediate inputs	22.5	Total payment to factors	77.5
1) Biofuel sector	3.2	6) Labor	75.0
2) Agricultural crops (except other crops)	5.0	7) Capital	2.0
3) Other crops	2.0	8) Land	0.5
4) Livestock	5.0		
5) Forestry products	7.3		
Overall total (intermediate input + production factors, 1 to 8)			100.0

Source: Authors' own assumptions, IEA (2015) and CBS (2010).

5.3 Land and natural water resources

5.3.1 Irrigated and non-irrigated land

The CBS (2015a) data separates irrigated agriculture from rainfed agriculture (except for some crops i.e. other crops in the SAM) and minor crops. Therefore, the division of land into irrigated and non-irrigated (other land in the SAM) from the 'income to land' perspective is based on the payments of these agricultural activities to water. Indicating that, land payments from sectors paying irrigation water, are allocated to irrigated land with zero payment to non-irrigated land, while sectors with no payment to irrigation water are assumed to pay the non-irrigated land with zero payment to irrigated land.

The challenge however was on the allocation of land income to the different household groups. For that, satellite data on the irrigated versus non-irrigated land by state (Abd Elbasit, 2016) are used to allocate land income to households in the different states. Within each state, land income is distributed over the household in different locations (rural and urban) and different income quintiles based on the income shares of the aggregated land account from the household survey (CBS, 2010).

5.3.2 Natural water resources as a separate production factor

The inclusion of a separate account for natural water resources becomes important as soon as one thinks to address long term planning issues that concern water use in the economy. This is one of the reasons that the water account in the SAM (commodities and activities) is disaggregated. Natural resources in the Sudan including land, water and forests are by law owned by the government while individual user rights come in the form of rent (mostly with long term contracts). At the same time, all the dams in the country are owned by the government as well as the majority of the large scale irrigation projects that use the Nile or

ground water. The absolute majority of the water used in the country is supplied at a very low price if not free of charge.

Against this background, we found including a separate account for natural water resources although with minor costs crucial to perform any water-related analysis. To do so, we assumed that the natural water resources are mainly consumed by the irrigation water activity with a very small value for porterage water and biofuel while the whole income generated (ownership) accrues to the government.

6 The Sudanese economy as depicted by the SAM

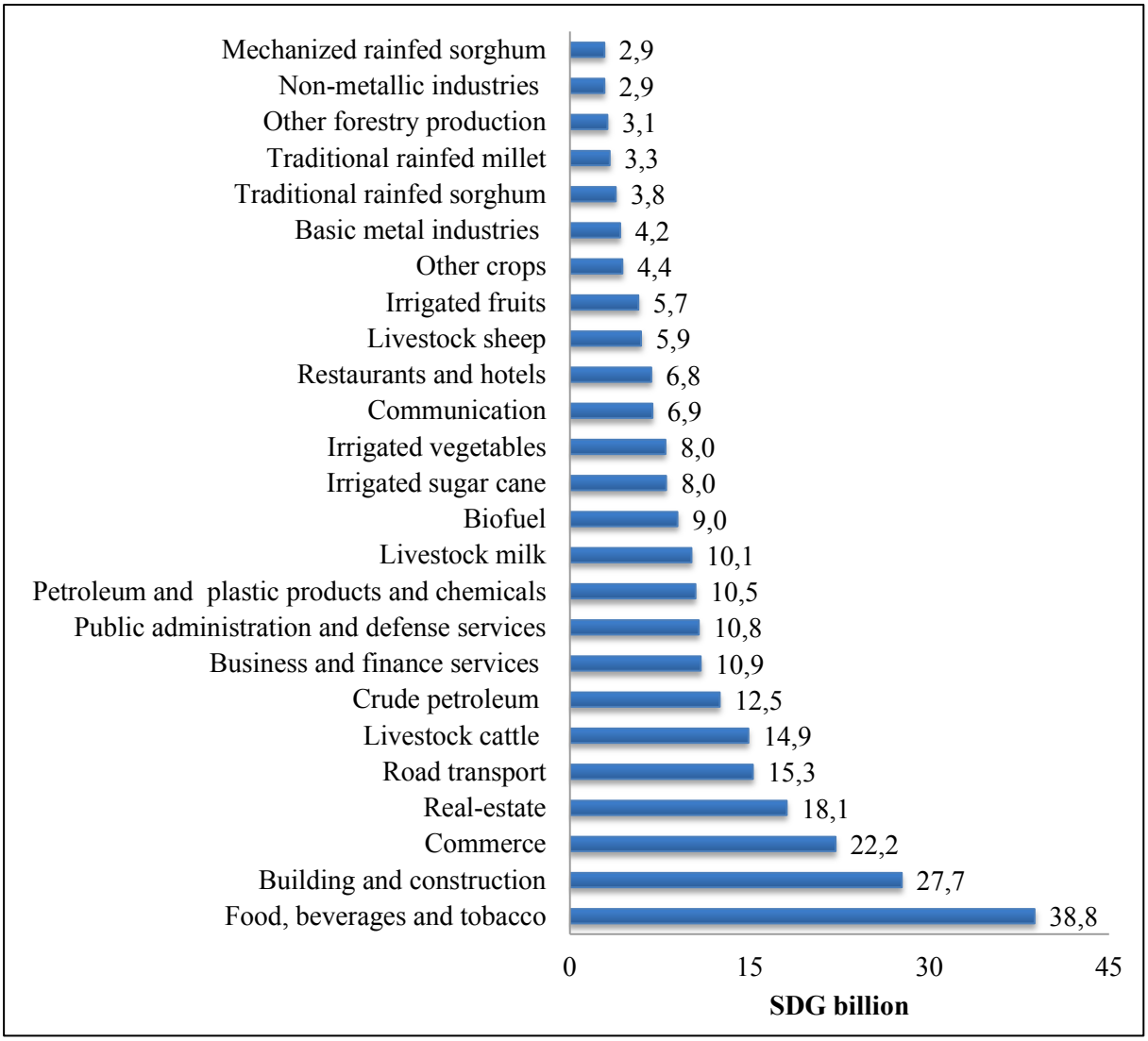
This section provides an overview of the Sudanese economy based on the SAM. It covers major sectors contributing to total output, major exported and imported commodities, classification of the commodity demand by commodity groups and demand categories and at the end it shows the distribution of total income across household groups as well as sources of household income.

6.1 Production

Total production (SDG billion) of each of the top 25 activities of the SAM (activities with percentage share in total output being equal to or more than 1%) is shown in Figure 1. Total output value in the Sudan in 2012 was SDG 299.0 billion (see also the Macro-SAM in Table 2), of which 5% comes from the livestock-cattle sector (the biggest single agricultural sector in the SAM), while the aggregated contribution of agriculture (including crops as well as all livestock categories) makes 28.3% of total output value. The sector “Food, beverages and tobacco” tops all sectors with SDG 38.8 billion (13%) contribution to total output. This is followed by the building and construction sector (SDG 27.7 billion, 9%), commerce (SDG 22.2 billion, 7.4%) and real-estate (SDG 18.1 billion, 6.1%).

It can be noted that the share of the petroleum sector is not anymore in a leading position with its percentage share in total output (crude and refined combined) not exceeding 8% (SDG 23.0 billion) of total output value.

Figure 1: Total output by activity in 2012 (SDG million)[13]



Source: 2012 SAM for the Sudan.

The relatively small contributions of the individual agricultural sectors such as traditional rainfed sorghum and millet are explained by the fine disaggregation of these sectors compared to others (e.g. food sector). The sesame sector for example, which does not appear in Figure 1, is represented in the SAM by three different sub-sectors based on the mode of irrigation (irrigated, traditional rainfed and mechanized rainfed). The total output of sesame is SDG 3.0 billion and its contribution to total output value is 1%.

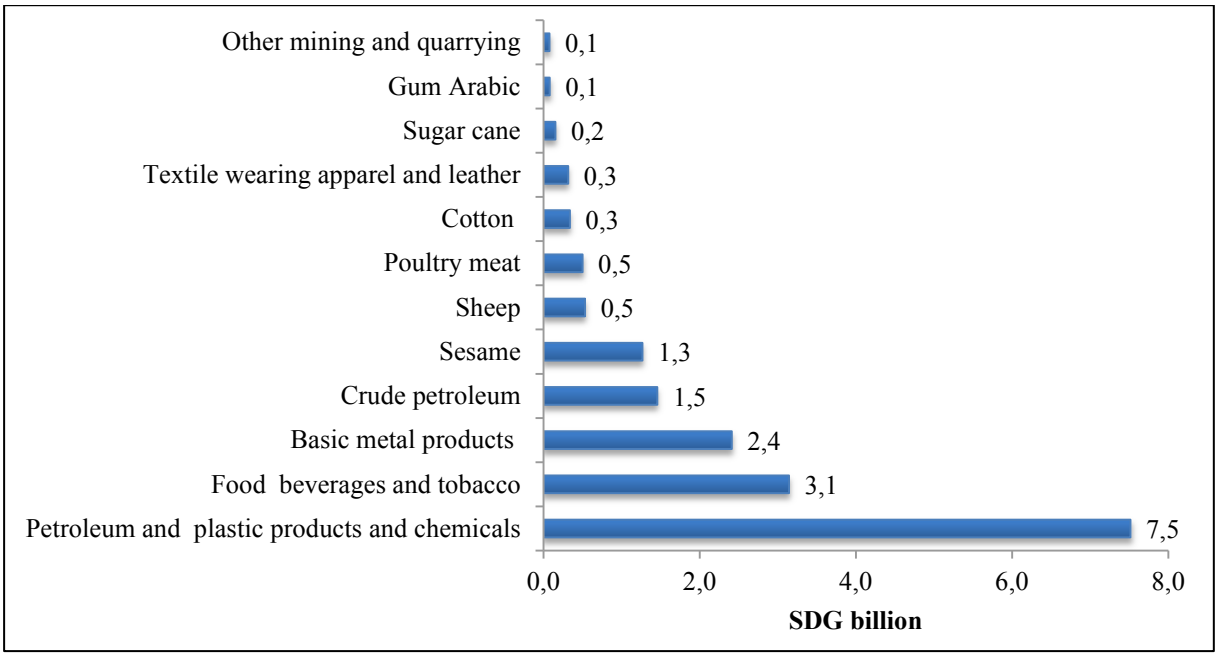
[13] Only activities contributing 1% or more to total output are included in the figure. Production is valued at producer prices (no taxes or subsidies included).

6.2 Trade

At the macro-level, the country witnessed a trade deficit of SDG 9.9 billion in 2012. This is particularly driven by the increasing petroleum imports after the separation of the Sudan in July 2011, with the share of petroleum products in total imports being 24.0%.

The 2012 Sudanese exports of goods and services are summarized in Figure 2. Among the 58 commodities of the SAM, 23 commodities are exported. Crude petroleum is no longer the most important export commodity, which it was in the past, and its share dropped to only 8.1% of total exports. Nonetheless, petroleum, plastic and chemical products combined in one commodity account in the SAM top Sudanese exports and contribute 41.8% (SDG 7.5 billion) to total exports. The basic metal commodity aggregation, which includes the recently evolving Sudanese export commodity, gold, represents 13.4% (SDG 2.4 billion) of total export value.

Figure 2: Exports of the Sudan in 2012 (SDG billion)

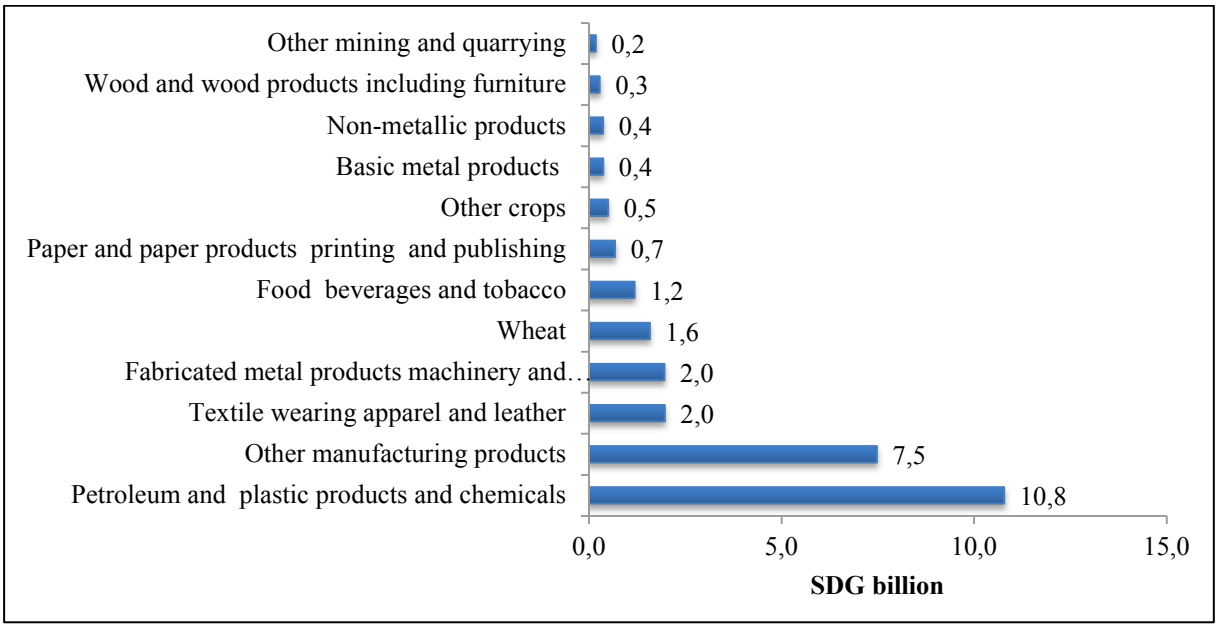


Source: 2012 SAM for the Sudan.

The 2012 Sudanese imports of goods and services are summarized in Figure 3. Among the 58 commodities of the SAM, 34 commodities are imported. The majority of the Sudanese imports (91.5%) are manufactured goods; of which petroleum, plastic and chemical products represent 38.8% in 2012. Total food imports (manufactured and non-manufactured constitute SDG 3.7 billion and 13.1% of total imports. The total value of non-manufactured imports (including services and crude petroleum) is SDG 2.4 billion, which makes 8.5% of total imports. Out of this SDG 2.4 billion, wheat imports value makes SDG 1.6 billion with a contribution to total imports value in 2012 of 5.7%. As depicted in Figure 3, this puts wheat in

the fifth rank among major Sudanese imports in 2012 and is therefore subject to a huge and controversial subsidy spending every year. The subsidy depicted in the SAM represents 5.1% of total wheat import value.[14]

Figure 3: Imports of the Sudan in 2012 (SDG billion)



Source: 2012 SAM for the Sudan.

The Sudanese agricultural sector with its contribution to the country's GDP of more than 30% makes a considerable contribution to the foreign exchange earnings especially after the decline in petroleum exports. Crops combined (led by sesame, cotton, sugar cane and gum Arabic) contribute SDG 1.9 billion (12.5%) to total exports, while livestock (live and slaughtered animals combined) makes SDG 1.1 billion (6.3%) of total exports in 2012.

6.3 Total commodity demand

To get an idea on the distribution of commodities over the different demand categories, commodities of the SAM are grouped into 10 as shown in Table 8. The table shows the percentage share of each demand category including intermediate, private, government, investment (including stock changes), and exports demands in the total demand value of each commodity group.

[14] Note that the subsidy is provided to importers as preferential foreign exchange and it is hard to gather accurate information about it.

Table 8: Categories of demand for commodities in the Sudan (% share in total demand)

	Intermediate	Households	Government	Investment	Exports	Total
Agriculture	16.0	69.5	0.0	2.1	12.4	100
Mining and petroleum	70.8	5.3	0.0	5.8	18.0	100
Food and beverages	40.1	48.2	0.0	4.4	7.3	100
Manufacturing	54.3	33.3	0.0	3.3	9.1	100
Energy	21.7	78.3	0.0	0.0	0.0	100
Water	47.8	51.7	0.0	0.5	0.0	100
Construction	19.9	3.5	0.3	76.2	0.0	100
Trade and business services	46.1	26.1	16.6	11.2	0.0	100
Transport and communication	55.7	39.1	0.0	5.2	0.0	100
Other services	19.5	65.5	13.1	2.0	0.0	100

Source: 2012 SAM for the Sudan.

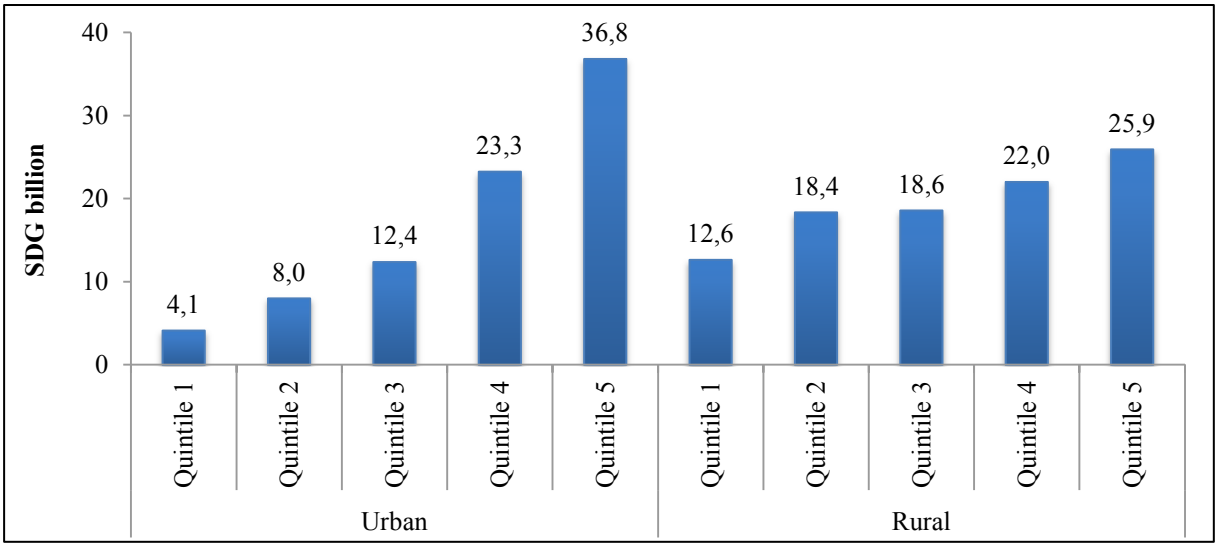
The energy commodities (electricity and biofuel) as well as agricultural products including livestock, forest products and fish are mainly demanded by households (78.3% and 69.5%, respectively), mining and petroleum products are mainly used as intermediate inputs (70.8%), while building and construction is mainly demanded for investment (76.2%).

6.4 Household income

Total income to rural and urban households divided by income quintiles is depicted in Figure 4. Figure 4 shows that income is more progressively distributed across urban than rural households. The shares of the income quintiles in urban areas (from quintile 1 to quintile 5) in total urban income are 4.9%, 9.5%, 14.6%, 27.5% and 43.5%, while those in rural areas are 13.0%, 18.8%, 19.1%, 22.6% and 26.6%, respectively. This shows that more than 70% of the urban income is concentrated in the hands of the top-two quintiles compared to less than 50% of the rural income owned by the top-two income quintiles in rural areas.

Income to households (by income quintile) from different sources is depicted in Figure 5. The distribution of households' income from different sources over household categories is based on the household survey of the CBS (CBS, 2010). There are 18 income sources reported in the survey, which are mapped to 6 accounts in the SAM, namely, land, labor, capital, government transfers, enterprises income and remittances. The specific mapping between the 18 and 6 income sources is provided in Appendix 2.

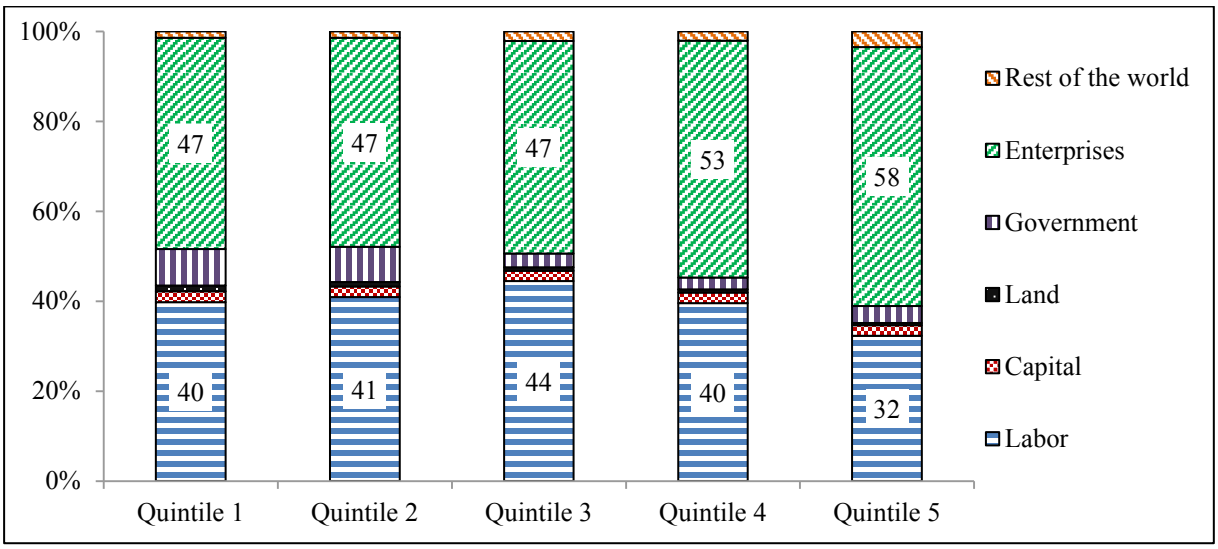
Figure 4: Total households' income by location and income quintiles (SDG billion)



Source: 2012 SAM for the Sudan.

A major characteristic of the pattern shown in Figure 5 is that the share of enterprises in total income to households in the different quintiles is relatively large. This large difference in quintiles can be explained by the ownership of enterprises not explicitly being stated in the survey and that all the income generated from industrial and trade activities of the survey is considered income from enterprises. Income to households from labor and government transfers are regressive as expected, implying that the poorer the household group, the more it relies on labor income relative to other sources and the larger the share of transfer income compared to richer households (Figure 5).

Figure 5: Sources of income to households in the five quintiles (percent)



Source: 2012 SAM for the Sudan.

7 Conclusions and suggestions for potential data improvement

The 2012 SAM for the Sudan is developed based on data gathered from different official sources in the Sudan, external sources, published research, unpublished data and satellite-based information. In addition, the SAM has also benefited from expert judgment and real life experiences.[15] The construction procedure and data compilation of the different submatrices is explained in details in the corresponding sections of this paper.

This is the first post-separation SAM for the Sudan, which is published at a stage where many research issues are pressing for which SAM-based analyses can provide considerable assistance to Sudanese policy makers. Therefore, it may be useful to highlight the reliability of the different submatrices, so that researchers willing to use, extend and/or improve the SAM can focus their efforts on the parts that need enhancement most urgently.

The reliability of the Macro-SAM level data is reasonably well developed. At the detailed (Micro-SAM) level, however, there are options for further refining and improving the quality of the data particularly in some submatrices or parts of submatrices. Therefore, Table 9 presents a data-reliability matrix that is meant to classify the quality of the data used to build each submatrix of the SAM (according to data sources and the procedures followed to compile them). It is important to note here that the data reliability matrix regards only the submatrices of the Micro-SAM and no reliability issues are raised about the Macro-SAM.

The following is a key explaining the idea of the data reliability grades and the criteria for labeling the submatrices:[16]

- Grade [A]: data of best reliability. This includes the submatrices based on National Accounts data and reliable CBS data that did not undergo considerable disaggregation depending on survey data, external data, assumptions or expert judgment. An example of this category is submatrix 1C, which is total output by activity (CBS, 2015a) and cell 8DX, which is the total direct tax revenue to the government. The latter is one value that is identical in the Macro and Micro-SAMs.

- Grade [B]: data of second best reliability. This includes the submatrices based on National Accounts data that is disaggregated using official surveys such as the household survey (CBS, 2010) or the labor force survey (MHRDL, 2013). This class does not undergo considerable disaggregation using external data, assumptions or expert judgment. An example of this category is submatrix 1H, which is households' consumption of commodities

[15] An example for the latter is the data on the cost structure of the porterage water activity for which some selected porterage water suppliers in Khartoum and Gezira states are interviewed. From a statistical view point, this is not sufficient, but it was the best which could be achieved within the work on this SAM.

[16] The data reliability matrix is the authors' idea, which does not build on any international consensus on data quality. Readers can assess the data quality based on their own standard by reading our description of each grade.

(CBS, 2015a and CBS, 2010) and cell 1G, which is government final consumption demand for commodities (CBS, 2015a).

- Grade [C]: data of third reliability level. This includes the submatrices based on National Accounts data or official survey data, but they are incomplete or aggregated. Therefore, external data, published research, assumptions or expert judgment are used to compile them in the desired submatrix form. An example of this category is submatrix 9C, which is the indirect taxes by each commodity (aggregates are from CBS, 2015, but disaggregation is based on 'net indirect tax' values by commodity, which stems also from CBS, 2015a).

- Grade [D]: data of fourth reliability level. This includes the submatrices based on National Accounts data or official surveys data, but they are incomplete or aggregated. Moreover, the available external data and published research are not sufficient to accomplish the desired level of disaggregation or are back dated. Therefore, this grade reflects the use of assumptions and/or expert judgment to compile the data in the desired submatrix form. Examples of this category are some parts of submatrix 1A, which is intermediate input by activity and commodity. This submatrix, as described in the corresponding section of this paper (CBS, 2015a), provides total intermediate input values for each activity. In addition, the submatrix is disaggregated using three different surveys; however, the three of them do not fully cover the full dimensions of the entire submatrix. Moreover, the industrial survey (MoI, 2005) dates back to 2005.[17] Therefore, this submatrix is the Authors' first recommendation for further improvement.

[17] Full lists of the activities and commodities accounts of the SAM are provided in Appendix 3, Appendix 4, Appendix 5 and Appendix 6.

Table 9: Data reliability matrix for the Sudan ranking data quality from A to D

Incomings \ Outgoings		C	A	L	K	N	H	G	E	IX	DX	I	D	W	T
		Commodity	Activity	Labor	Capital	Land	Households	Government	Enterprises	Indirect tax	Direct tax	Investment	Stock changes	World	Total
1	Commodity		D				B	B				B	B	A	B
2	Activity	A													A
3	Labor		B											C	C
4	Capital		B											A	B
5	Land		C												C
6	Households			B	B	B		B	C					B	C
7	Enterprises				A			A							B
8	Government								A	A	A			A	A
9	Indirect tax	C	C												C
10	Direct tax						C		A						B
11	Savings				A		D	A	D					A	B
12	Stock changes											A			A
13	World	A		C	B		C	B							B
14	Total	B	A	C	B	C	C	B	C	A	A	B	B	B	

Source: Authors' own elaboration.

We will be making this document freely available online so that the SAM can be further improved upon and we are willing to share and cooperate with those wishing to do so. We believe that improvements can be in various ways such as: 1) improving the quality of the SAM submatrices (upgrading any submatrix, especially grade D submatrices); 2) expanding the dimensions of one or more submatrices depending on the areas of interest; or 3) updating the entire SAM or one or more submatrices of it towards a more recent year. The latter will be very relevant to the industrial intermediate input submatrix which uses 2005 industrial survey data (MoI, 2005). The data will be made available soon to interested collaborators and will be made public thereafter.

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Appendices

Appendix 1: List of activity and commodity accounts in the Micro-SAM and their correspondence with CBS data

CBS (2015)		Sectors in the Micro-SAM	
No.	**Description**	**No.**	**Description**
1	Irrigated crops	1	Cotton
		2	Sorghum
		3	Wheat
		4	Maize
		5	Groundnut
		6	Millet
		7	Sesame
		8	Sugar
		9	Fruits
		10	Vegetable
		11	Egyptian bean
		12	Sunflower
2	Mechanized rainfed crops	13	Cotton
		14	Sorghum
		15	Millet
		16	Sesame
		17	Sunflower
3	Rainfed traditional crops	18	Sorghum
		19	Wheat
		20	Maize
		21	Groundnut
		22	Millet
		23	Sesame
		24	Fruits
		25	Vegetable
4	Minor crops and byproducts	26	Other crops
5	Livestock	27	Cattle
		28	Sheep
		29	Goats
		30	Poultry meat
		31	Other live animals
		32	Milk
		33	Eggs

CBS (2015)		Sectors in the Micro-SAM	
No.	**Description**	**No.**	**Description**
6	Forestry	34	Gum Arabic
		35	Other forestry production
7	Fishing	36	Fishing
8	Petroleum	37	Crude petroleum
9	Other mining and quarrying	38	Other mining and quarrying
10	Food , beverages and tobacco	39	Food , beverages and tobacco
11	Textile, wearing apparel & leather	40	Textile, wearing apparel and leather
12	Wood and wood products including furniture	41	Wood and wood products including furniture
13	Paper and paper products printing and publishing	42	Paper, paper products, printing and publishing
14	Chemicals including petroleum and plastic products	43	Petroleum products, plastic and chemicals
15	Non-metallic industries	44	Non-metallic industries
16	Basic metal industries	45	Basic metal industries
17	Fabricated metal products machinery and equipment	46	Fabricated metal products machinery and equipment
18	Other manufacturing industries	47	Other manufacturing industries
19	Electricity	48	Electricity
20	Water	49	Water
21	Building and construction	50	Building and construction
22	Commerce	51	Commerce
23	Restaurants and hotels	52	Restaurants and hotels
24	Air transport	53	Air transport
25	Road transport	54	Road transport
26	Rail transport	55	Rail transport
27	Water transport	56	Water transport
28	Communication	57	Communication
29	Pipe line	58	Pipe lines
30	Finance	59	Finance
31	Insurance	60	Insurance
32	Real -estate	61	Real-estate
33	Business services	62	Business services
34	Public administration and defense services	63	Public administration and defense services
35	Education services	64	Education
36	Health services	65	Health
37	Other community, social and sanitary services	66	Other community, social and sanitary services
38	Social recreational and related community services	67	Social recreational and related community services
39	Domestic services of households	68	Domestic services of households

Source: 2012 SAM for the Sudan and CBS (2015).

Appendix 2: Correspondence between the SAM accounts and the 2009 households' survey (income sources)

The SAM accounts		Household survey 2009	
No.	**Description**	**No.**	**Description**
1	Land	1	Crops
		2	Horticulture products
		3	Other agricultural activities
2	Labor	4	Fish and its products
		5	Forestry products
		6	Salaries and payments
		7	Other non- agricultural sources
3	Capital	8	Animal sales
		9	Animal products
		10	Poultry and its products
		11	Rented estates
		12	Other rents
		13	Transportation
		14	Transfers from inside Sudan
4	Enterprises	15	Industrial activities
		16	Trade
5	Government	17	Supports
6	Rest of the world	18	Transfers from outside Sudan

Source: Authors' assumptions and Household survey (CBS, 2010).

Appendix 3: List of the agricultural activities and commodities and their correspondence

Activities		Commodities	
No.	**Description**	**No.**	**Description**
Agricultural crops			
1	Irrigated cotton	1	Cotton
2	Mechanized rainfed cotton		
3	Irrigated-sorghum	2	Sorghum
4	Mechanized rainfed sorghum		
5	Traditional rainfed sorghum		
6	Irrigated-wheat	3	Wheat
7	Traditional rainfed wheat		
8	Irrigated maize	4	Maize
9	Traditional rainfed maize		
10	Irrigated groundnut	5	Groundnut
11	Traditional rainfed groundnut		
12	Irrigated millet	6	Millet
13	Mechanized rainfed millet		
14	Traditional rainfed millet		
15	Irrigated-sesame	7	Sesame
16	Mechanized rainfed sesame		
17	Traditional rainfed sesame		
18	Irrigated sugar cane	8	Sugar cane
19	Irrigated fruits	9	Fruits
20	Traditional rainfed fruits		
21	Irrigated vegetables	10	Vegetable
22	Traditional rainfed vegetables		
23	Irrigated Egyptian beans	11	Egyptian beans
24	Irrigated sunflower	12	Sunflower
25	Mechanized rainfed sunflower		
26	Other crops	13	Other crops
Livestock			
27	Livestock cattle	14	Cattle
28	Livestock sheep	15	Sheep
29	Livestock goats	16	Goats
30	Livestock poultry meat	17	Poultry meat
31	Other livestock	18	Other livestock
32	Livestock milk	19	Raw milk
33	Livestock eggs	20	Eggs
Forest			
34	Gum Arabic	21	Gum Arabic
35	Other forestry production	22	Other forestry products
Fish			
36	Fishing	23	Fishing

Source: 2012 SAM for the Sudan.

Appendix 4: List of the industrial activities and commodities and their correspondence

Activities		Commodities	
No.	**Description**	**No.**	**Description**
1	Crude petroleum	1	Crude petroleum
2	Other mining and quarrying	2	Other mining and quarrying
3	Food, beverages and tobacco	3	Food beverages and tobacco
4	Textile, wearing apparel and leather	4	Textile wearing apparel and leather
5	Wood and wood products including furniture	5	Wood and wood products including furniture
6	Paper and paper products printing and publishing	6	Paper and paper products printing and publishing
7	Petroleum and plastic products and chemicals	7	Petroleum and plastic products and chemicals
8	Non-metallic industries	8	Non-metallic products
9	Basic metal industries	9	Basic metal products
10	Fabricated metal products machinery and equipment	10	Fabricated metal products machinery and equipment
11	Other manufacturing industries	11	Other manufacturing products

Source: 2012 SAM for the Sudan.

Appendix 5: Energy and utilities activities and commodities and their correspondence

Activities		Commodities	
No.	**Description**	**No.**	**Description**
1	Hydropower electricity	1	Electricity
2	Oil-based electricity		
3	Biofuel	2	Biofuel
4	Irrigation water	3	Irrigation water
5	Pipe water	4	Pipe water
6	Porterage water	5	Porterage water
7	Building and construction	6	Building and construction

Source: 2012 SAM for the Sudan.

Appendix 6: List of the service activities and commodities and their correspondence

Activities		Commodities	
No.	**Description**	**No.**	**Description**
1	Commerce	1	Commerce
2	Restaurants and hotels	2	Restaurants and hotels
Transport and communication			
3	Air transport	3	Air transport
4	Road transport	4	Road transport
5	Rail transport	5	Rail transport
6	Water transport	6	Water transport
7	Communication	7	Communication
8	Pipeline	8	Pipelines
Other services			
9	Finance	9	Finance
10	Insurance	10	Insurance
11	Real-estate	11	Real-estate
12	Business services	12	Business services
13	Public administration and defense services	14	Public administration and defense services
16	Community social and other services, other community and social services	13	Community, social and personal services, other community and social services
14	Education	15	Education
15	Health	16	Health
17	Social recreational and related community services	17	Social recreational and related community services
18	Domestic services of households	18	Domestic services of households

Source: 2012 SAM for the Sudan.