HOW USEFUL IS A REGIONAL SAM IN EVALUATING REGIONAL PROJECTS IN SRI LANKA? AN ILLUSTRATION FOR POST-WAR REGIONAL DEVELOPMENT POLICY ANALYSIS.

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ABSTRACT: Over the last several decades, Social Accounting Matrices (SAMs) have emerged as a widely accepted method for the presentation of macroeconomic data and an analytical technique for impact analyses at national, regional and village levels. Although there is a large body of literature concerning the construction and application of SAMs, there are only a few impact evaluations with regional and village SAMs. This is particularly evident when focusing on the impact of regional investment projects in developing countries. In this paper, we have attempted to demonstrate how a regional SAM can successfully be applied to evaluate the impact of an irrigation project in the Southern Province of Sri Lanka. This example clearly demonstrates the possibility of using regional and village level SAMs in evaluating post-war development projects, such as infrastructure and irrigation projects, in Sri Lanka.

KEY WORDS: Regional Development, Economic model, Social Accounting Matrix, Policy Analysis, Udawalawe, Sri Lanka

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1. INTRODUCTION

Following the end of nearly three decades of separatist war in May 2009, Sri Lanka is attempting to re-establish the livelihoods of war torn Northern and Eastern provinces through large scale programs of resettlement, rehabilitation, reconstruction, reintegration, reconciliation (known as five 'R's) and investment in new infrastructure projects. The economic development process within the country is also being accelerated in response to the delays encountered from this period of armed conflict. Regional inequality, rural poverty and exclusion from economic benefits of globalization have long been recognized as important root causes of political violence in Sri Lanka, with the unequal regional distribution of economic opportunities in the country well documented (see for example, Central Bank of Sri Lanka, 2010; UNDP, 1998; Karunanayake, 2001; Dangalle, 2005; Wanasinghe, 2001; Uduporuwa, 2007). According to estimates from the Central Bank of Sri Lanka (2011), 44.4 percent of the country's Gross Domestic Product (GDP) is produced within the urbanized Western province despite it only housing 28.4 percent of the population. In contrast to these figures, the other eight provinces which house 71.6 percent of the total population, produce only 55.6 percent of national GDP. Given this unequal geographical distribution of economic opportunities, it is not surprising to see that poverty incidence also varies from region to region. For example, whilst the poverty head count in urbanized Colombo is less than 4 percent, the count of rural *Batticaloa* in the East is over 20 percent (Department of Census and Statistics, 2010). Even though the country has implemented a number of rural development and poverty reduction projects during last six decades of its post-independence era, 9 percent of its population is still living below the absolute national poverty line. This has led the current Sri Lankan government to launch large sized infrastructure projects to develop the war torn Northern and Eastern provinces and to reduce regional inequality and poverty; created in part by the nearly three decades of conflict between the Sri Lankan security forces and the separatist group of the Liberation Tigers of Tamil Eelam (LTTE; known as the Tamil Tigers). In order to achieve the long-term goals of growth, peace and a regional harmony in post war Sri Lanka, the current government has recognized the need for strategies which equitably share the benefits of development projects amongst the countries different geographical regions.

In order to evaluate these post-war regional development projects in Sri Lanka, there is a need to undertake an economic impact evaluation by use of certain economic tools. For the purpose of assessing regional policies, there are a number of economic techniques which are widely cited as applicable. These include: cost-benefit (C-B) analysis, regional input-output (I-O) and social accounting matrix (SAM) models, regional computable general equilibrium (CGE) models, and econometric models. However, because of data problems and the costs associated with creating regional CGE and econometric models in many developing countries regional policy analysts often use the I-O and SAM models (Partridge and Rickman, 2010). Although these regional models have been used to analyse regional and village level issues in many developing countries (Hartono and Resosudarmo, 2008; Keuning, 1997; Pradhan *et al*., 2006; Round, 2003b), few regional level quantitative analyses have been undertaken for Sri Lanka mainly due to lack of appropriate economic models, regional economic data and the shortage of regional policy analysts (Wijerathna and Karunagoda, 2007). In spite of this regional policy analysis is still paramount in the post-war development strategies of Sri Lanka.

Based on this evident gap in literature, the main objectives of this paper are to develop a SAM-based model for quantitative analysis of a regional development project in Southern Sri Lanka, specifically the *Udawalawe* irrigation development project, and to demonstrate how a SAM-based model can successfully be used in evaluating the impact of post-war development projects in Sri Lanka, especially in the Northern and Eastern regions of the country. The SAM developed in this study is based on a data framework for analysing the structure of a regional economy. Policy experiments were also conducted to analyse the possible impacts of potential pro-poor development policies.

The rest of the paper is structured as follows. The next section will present a brief technical description of SAM followed by an illustration of the procedure of compiling a SAM for the *Udawalawe* left bank region (a small region in the Southern province of Sri Lanka). Section three will then evaluate the impact of an irrigation project on a rural economy and discuss the results of the policy experiments. The final section will summarise the paper and provide any concluding remarks.

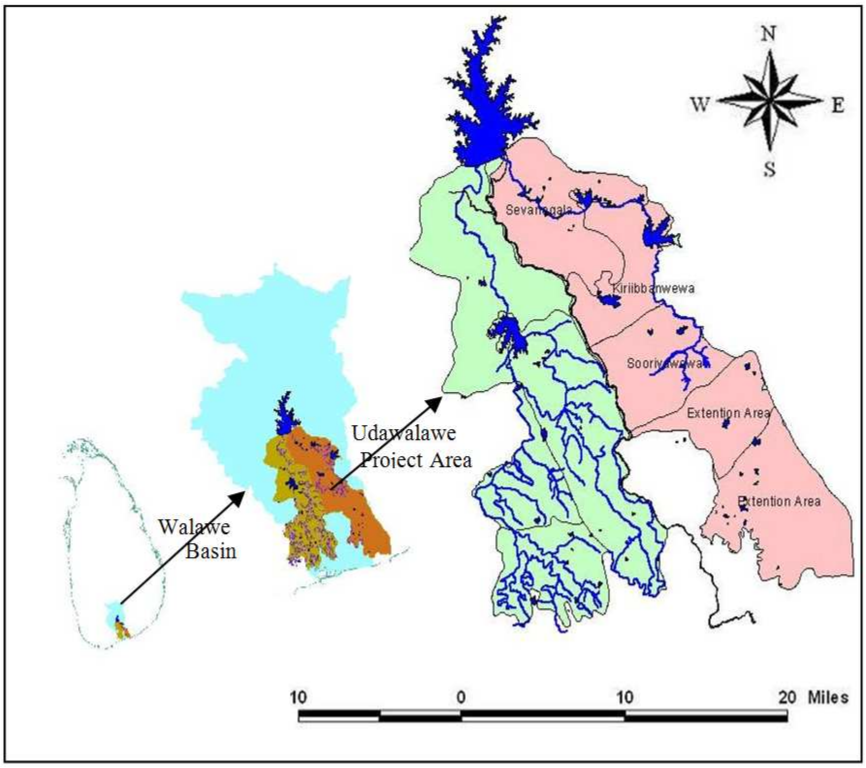
2. DEVELOPMENT OF A SAM FOR THE REGIONAL ECONOMY OF UDAWALAWE IN SRI LANKA

A social accounting matrix (SAM) is a comprehensive economy-wide data framework that represents the circular flow of income and expenditure in the economy of a nation or region, within a given time (Lofgren and El-Said, 1999; Keuning and De Ruijter 1988). This matrix was first developed by Richard Stone (in association with Brown) in the 1960s for the Cambridge Growth Project and has subsequently been used by a number of authors in various studies (see for example, Pyatt and Roe, 1977). Initially SAMs were used only for national level accounting purposes, but later a demand arose for applying them in regional and local level activities (Kinlen, 2003; Thorbecke, 2000). They can also be used in descriptive or prescriptive analysis of an economy (Fannin, 2001). A SAM differs from other economic models since it has explicitly been designed to depict how income is both generated and distributed within an economy. A SAM is an important tool for policy analysts to measure impacts, make predictions and also to examine the link between social and economic development (Pyatt and Round, 1977). Given the large body of literature on construction of SAMs, their usefulness and their applications (see for details: Round, 2003a; Thorbecke, 2000; Sadoulet and de Janvry, 1995; Subramanian and Sadoulet, 1990), this paper does not intend to repeat what has already been documented in the literature. Rather, the ensuing paragraphs delineate a brief history of Sri Lankan SAMs and the construction of a SAM for a regional economy.

The history of developing SAMs for the Sri Lankan economy dates back to the 1970s. The SAM constructed by Pyatt and Roe, (1977) for Sri Lanka was among the first few SAMs constructed for developing countries and the first well-documented SAM in the world. Following this, however, a number of attempts to develop new SAMs for Sri Lanka failed (see Bandara and Kalegama, 2008 for a detailed history of SAMs in Sri Lanka) until a new SAM was eventually constructed by Naranpanawa and Bandara (2006). Although a number of policy analyses based on the 1970 Sri Lankan SAM were undertaken in the late 1970s and the early 1980s (see for example, Pyatt and Round, 1979; de Melo, 1982), there have been very few new attempts to undertake SAM-based impact analyses in Sri Lanka. To our knowledge, there is no single regional or village SAM for Sri Lanka and this study is the first attempt of such type. This paper will therefore assist other policy analysts to develop SAMs, which can similarly be applied to the war-torn Northern and Eastern provinces. This first attempt has two basic components. First, it develops a SAM for a selected small region using a set of household data gathered from a household survey, and secondly it analyses the potential impacts of selected pro-poor development policies within a SAM based model.

The development phase of a SAM normally starts with the identification of all economic agents and transactions in a selected economy (Kiyoshi 2004). Basically, there are two different approaches for constructing SAMs which are used by the practitioners; (1) top-down approach and (2) bottom-up approach. In the top down approach, the process begins with a highly aggregated SAM constructed with already estimated summary accounts for a country or a region. In contrast, the bottom up approach starts with disaggregated data sets compiled by primary data sources such as household surveys and rapid appraisals. National level SAMs usually follow the top down approach and are mostly based on national account statistics (Sadoulet and de Janvry, 1995). Round (2003a and 2003b), supports the top-down approach for a national SAM when it is impossible to define detailed data needs for compiling a SAM given the degree of country specificity. He further emphasises that national accounts of a country should be the starting point of a SAM. Some other practitioners like Jabara *et al.* (1992), Taniguchi (2003), Shiferaw and Holden (2000), Alarcon, J. (2005), Haggblade *et al.* (1991) and Thorbecke (2000) have alternatively discussed the importance of bottom-up approach and use of household data in compiling sub-national level SAMs. SAMs with the bottom-up approach are advantageous in sub-national level analysis for two reasons. Firstly, instead of starting with some conventions on income and expenditure shares based on national accounts, the construction of a SAM begins with actual data collected at the ground level and calculation of income and expenditure shares with collected data. Secondly, they are very flexible since the analyst can decide the level of disaggregation and accounts according to objectives and analytical requirements (Adelman *et al.*, 1988; Lewis and Thorbecke (1992); Round, 2003a; Stats, 2005; Taniguchi, 2003).

Given its role in assisting the regional development goals of the country, the *Udawalwe* irrigation project area of the Southern Province in Sri Lanka was selected for this study. It is one of the major multipurpose development projects implemented by the government of Sri Lanka after independence was gained from the British in 1948. The *Udawalawe* project is located at the boundary of the wet and dry Zones of Sri Lanka, around 200 km Southeast from Colombo (see Figure 1). The government of Sri Lanka initiated this project in 1969, with a plan to develop 23,000 hectares of low productive and unused lands in the Southern dry zone into irrigated agriculture (ADB 1969; Nijman 1991). The improvement of food security in the country, reduction of population pressure in the wet zone by shifting people to irrigated settlement, addition of some hydro power to the national grid and reduction of long lasting rural poverty were the key objectives of this multi-purpose development project (Wijerathna 2009; Wijerathna and Jayakody 2007, NIPPON KOEI, 1996, 2005).



Source: Wijerathna (2005).

Figure 1. Map of Study Area.

Even though the construction of this planned reservoir was completed in 1969, the development downstream was carried out in different phases mainly due to capital constraints. The downstream area identified for development basically had two divisions which were the left and right bank. The left and right bank main canals (LBMC and RBMC) starting from the reservoir and flowing along the ridges of the area identified for development, were designed to irrigate 12,000 hectares into the left bank and another 11,000 hectares into the right bank. Both left and right bank areas were again divided into smaller geographical areas called blocks, to assist with planning and implementing development activities. The right bank was given the first priority in development agenda mainly because of the higher population density in the area (compared to the left bank). Construction of the left bank main canal was completed up to *Kiriibbanwewa* tank in 1969. The command area of the left bank however, was divided into four blocks with development scheduled to take place in five steps. The head reach or the first block was identified for sugarcane cultivation and developed under the *Sevenagala* sugar cane project in 1983. Through this project a total of 2,300 households were settled in 2,000 hectares of irrigated lands, with another 1,200 farm households settled in 2,100 hectares of un-irrigated lands. Households in the irrigated area were provided an allotment of 0.75 hectares of land to cultivate sugar cane and 0.25 hectares for rice paddies. Settlers in un-irrigated area, however, were provided an allotment of 1.75 hectares of land for sugarcane cultivation under rainfed condition. The second block, named *Kirriibanwewa,* was developed for paddy cultivation. Construction of the field level canal system of this block was completed in 1993. About 2,000 farmers were settled in the area and two acres of irrigable lands and half an acre of highlands for homestead were provided to each farming household. Development of the third block, *Sooriyawewa,* was the next completed in 2000. Around 3000 families were settled in this area within 2,300 hectares of irrigated lands (Hussain *et al.*, 2004). While the majority of the land in this block was developed for paddy cultivation, some land was conversely developed to grow other field crops (OFC), given the limitations in water availability experienced by some farmers with irrigable low lands. Developments in the fourth block, named as *Mayurapura,* were planned to be implemented in two phases with the construction of first phase initiated in 2001. By 2002, however (the time of household survey), irrigation water was available only up to the third block, *Sooriyawewa*. Despite this, some farmers settled in non-irrigated areas of *Mayurapura* (the tail end of the left bank area) and were carried on rain-fed slash and burn (*chena*) cultivations, and paddies in small pockets with water received from rain-fed tanks in the area (Wijerathna and Jayakody, 2007). The total area actually developed by 2002 (the time of data collection) was 11,000 hectares in the RBMC and 6,400 hectares in the LBMC.

According to records held by the *Mahaweli Authority* of the Sri Lankan government, the *Udawalawe* left bank project area consisted of 16,567 households (farm and non-farm) and an estimated population of 74,000 during the study period. This area is largely rural, however there are four semi-urban centres close to the study area; namely *Sooriyawewa*, *Hambantota*, *Ambalantota* and *Embilipitiya*. *Embilipitiya* is the closest main town/city to the study area, with the right bank main canal of the reservoir passing through the city. Other infrastructure facilities such as electricity, roads, schools and hospitals are reasonably well developed in some parts of the project area (Hussain *et al.* 2009). The majority of the first generation settler families depend on farming for a livelihood, whilst a considerable number of the second generation family members are instead employed in agricultural, non-agricultural or service sectors both within and outside of the project area. Sugar cane is the main crop in the first block or *Sevenagala* area since cultivation of this crop is mandatory in lands developed under the sugarcane project. To maintain subsistence, however, farmers in the area also cultivate paddy. With regards to those farmers who cultivate sugarcane, they generally have a forward contract system with the sugar cane factory located at the vicinity of the *Udawalawe* reservoir. This sugarcane factory assists farmers in acquiring inputs such as planting materials, fertilizer and other chemicals.

Looking now at the second block, or *Kirriibbanwewa* area, paddy is the main crop of the majority of farmers, followed by the cultivation of bananas and OFCs. In the third developed block, *Sooriyawewa*, both paddy and banana are dominant crops with some farmers also cultivating OFCs. The majority of farmers in the area have also adopted modernized techniques. That is, they are cultivating improved varieties and using a considerable amount of chemical fertilizer and machinery. As fertilizer or chemical products are not produced locally, farmers buy these products from dealers in nearby towns directly or through retailers in their area. The major share of agricultural output is traded through retail traders and dealers in the area as primary commodities. The annual average household income is estimated as Rs 105,000 (1117 AUD) and about 50 percent of this is attained directly from the cultivation of crops (Wijerathna 2009).

Data Collection

Data required for the Regional SAM developed in this paper was gathered from various sources using a multitude of techniques. Primarily though, it was compiled using a dataset gathered from two household surveys carried out with a representative sample from the *Udawalawe* left bank area. This sample included 712 households selected with a multistage stratified random sampling technique. The study area, *Udawalawe* left bank, was initially stratified into five strata, in order to take into account the variation in the criteria, namely (1) the availability of irrigation infrastructure, (2) condition of the irrigation infrastructure, and (3) the cropping pattern. The existing project blocks (as described above; *Sevanagala, Kiri-ibbanwewa* and *Sooriyawewa*) were identified as three different strata. The un-irrigated rain-fed area at the tail end of the project (which is identified for the development by extending the irrigation and is thus called as extension area) and the non-irrigated sugarcane cultivated area in *Sevenagala* (*Sevenagala* rain-fed) were identified as another two strata. In the second stage, one to two clusters representing each of the strata were selected. A cluster was defined as a command area, under a canal in the case of irrigated areas, and as a village or division, in case of rain-fed areas. As a result of the above criteria/characteristics, it was acknowledged that the clusters within a stratum may not always be homogeneous, and as such there was the chance of variations arising, in terms of access to water, within clusters located in the same stratum. Given this, clusters were chosen to represent the potential differential access to water within a stratum. For example, in rain-fed areas, criteria such as the size of village or division, access to markets, and period of residence of settlers, were used for the selection of representative clusters.

In the third stage, a systematic random sampling procedure was adopted to select the sample within the selected cluster. This systematic random sample was drawn from a sampling frame of a complete list of households in a cluster. The number of households within each cluster was decided based on the total number of households in the block, which represented about 4.5 percent of the total households in the study area. However, factors such as the adequate representation of the variations within the study area, adequacy of the sample for statistical validity, and cost and time frame for the completion of surveys were also considered in selecting an appropriate sample size.

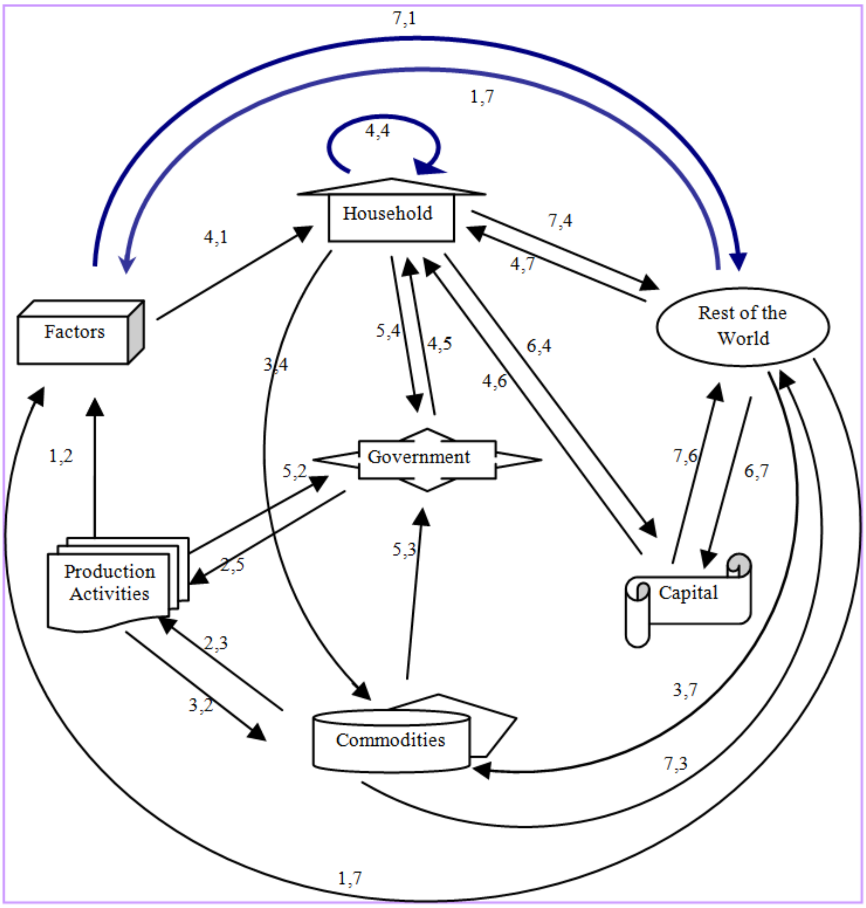
A comprehensive and semi-structured household level questionnaire was used for data collection. A one year period from October 2001 to

September 2002 was considered as the reference period. This period of one year was justified as it covers two full agricultural seasons for seasonal crops led by paddy. The first and second surveys were carried out in June and November 2002, at the end of the major and minor seasons respectively.

A series of interviews with farmers and other stakeholders of private and public sector institutions was conducted to understand different income generating activities, marketing channels, saving patterns, credit markets, and expenses such as taxes. Secondary data on factors such as population, production activities, businesses, taxes etc. were also collected from published and unpublished reports of the *Mahaweli* Authority, Central Bank of Sri Lanka, Department of Census and Statistics, International Water Management Institute, and Institute of Policy Studies.

Designing a regional SAM

A SAM for the *Udawalawe* Project area was constructed by extending the typical SAM with seven categories of accounts. Figure 2 and Table 1 show the seven major accounts identified for the Macro SAM. Following this, seven macro accounts were disaggregated into 52 micro accounts to represent different identified economic activities and agents in the area (see Figure 3). The study objectives and the availability of data were considered in deciding the number of accounts in the micro SAM and classifying them.



Source: Wijerathna (2009)

Figure 2. Classification of Accounts.

Table 1. SAM Accounts

		1	2	3	4	5	6	7	
		Factors of Production	**Production Activities**	**Commodities**	**Households**	**Government**	**Institutions - Capital Account**	**Rest of The World (Row)**	**Total**
1	**Factors of Production**		Factor Income / Value Added					Factor Income from Row.	Total Factor Income
2	**Production Activities**			Production					Gross Value of Output
3	**Commodities**		Intermediate Consumption		Consumption Expenditure on Goods			Export of Goods & Services	Aggregate Demand
4	**Households**	Allocation of Factor Income to HH			Inter Household Transfers	Transfer Payments to HH	Borrowings & Withdrawals from Savings	Transfers from Row	Total Current Receipts to Household
5	**Government**		Indirect Taxes	Import Tariff	Direct Tax-Income Tax				Total Current Receipts to Government
6	**Institutions - Capital Account**				Household Savings			Net Capital Transfers From Row	Total Capital Receipts
7	**Rest of The World (Row)**	Leakage of Factor Income	Import of Raw Materials	Imports	Household Expenditure on Imports		Import of Capital Goods		Leakages Payments to Abroad
	Total	Factor Income	Total Cost Of Production	Aggregate Supply	Total Current Outlays Of Households	Total Current Outlays Of Government	Total Capital Payment Of Households	Total Receipts From Abroad	Total

Source: adapted from Pyatt and Roe (1977), Sadoulet and de Janvry (1995) and Wijerathna (2009)

Figure 3. Accounts in Disaggregated SAM

1	Factors	Land and family labour Sevenagala
2		Land and family labour Sevenagala
3		Land and family labour Kiriibanwewa
4		Land and family labour Sooriyawewa
5		Land and family labour Extension
6		Skilled workers
7		Unskilled workers
8		Capital Assets (for rent)
9	Activities	Paddy
10		Sugarcane
11		Banana
12		Other field crops (OFC)
13		Livestock
14		Fishing
15		Enterprises
16		Processing
17		Trade
18		Constructions
19		Service sector
20		Renting machinery
21	Commodities	Rice
22		Other cereals
23		Wheat flour
24		Vegetables
25		Meat, fish, milk and eggs
26		Other foods
27		Energy
28		Services consumed
29		Other consumer items
30		Recreation and ceremony
31		Manufactured items
32		Paddy
33		Sugarcane
34		Banana
35		Other field crops
36		Constructions service
37		Seed
38		Cash inputs (Fertilizer, Pesticides etc)
39		Other

Figure 3. Continued. Accounts in Disaggregated SAM

40	Households	Household in 1st income decile
41		Household in 2nd income decile
42		Household in 3rd income decile
43		Household in 4th income decile
44		Household in 5th income decile
45		Household in 6th income decile
46		Household in 7th income decile
47		Household in 8th income decile
48		Household in 9th income decile
49		Household in 10th income decile
50		Government
51		Capital
52		Rest of the world

Source: the Authors

Land, labour and capital assets for renting were identified as the basic factors. As it is difficult to separate return to unpaid family labour, and family owned land (either from agricultural activities or household level small scale enterprises), the returns to family owned inputs from both agricultural and small scale enterprises were calculated with the residual method and it was defined as the restricted profit. Next, the restricted profits were assigned to five accounts defined for the respective geographical areas that were defined as the five strata in the sample. Paid labour was separated into two categories which were skilled and unskilled labour. Labour employed in agriculture, livestock and fishing was considered as unskilled labour whilst labour employed in service sector, industry and constructions was considered as skilled labour. Skilled labour in the service sector included a position of employment in Government and other public services such as police, armed forces, security companies, private companies and institutions, transport sector, financial business, wholesale and retail trade, telecommunication, hotels and restaurants and other personal services. Skilled labour in the industry sector included employment in mining, manufacturing and processing companies. As the industry sector was not significant in this region, a separate industry account was not classified and the factor income received from industries in the rest of the world was added to the service sector. The final skilled labour sector, constructions, included employment in constructing irrigation canals, roads and houses. A separate construction sector was identified in this SAM as the focus of the study is on the impact of project closure on the construction sector. Land, houses and machinery for rent were considered as a combined factor of production capital. Finally, as shown in Figure 3, there were eight accounts of factors of Production. These were: (1) land and family labour *Sevenagala* irrigated area, (2) land and family labour *Sevenagala* rain-fed area, (3) land and family labour *Kiriibanwewa*, (4) land and family labour *Sooriyawewa*, (5) land and family labour extension area, (6) skilled workers, (7) unskilled workers, and (8) capital (assets for rent).

Twelve production activities identified in the region were divided into two basic categories which were agricultural and non-agricultural activities. As shown in Figure 3, the agricultural activities included in the first six production accounts were: (1) paddy, (2) sugarcane, (3) banana (4) other field crops like onion, chilli, vegetables, pulses, other grains (e.g. *kurakkan*), oil crops (e.g. gingelly), (5) livestock keeping, (6) fishing. The non-agricultural activities included in the rest of production accounts were; (7) enterprises, (8) processing, (9) trade, (10) construction, (11) service sector, and (12) renting machinery.

As also demonstrated in Figure 3, the commodity account was disaggregated into 19 sub accounts to represent the major household consumption and input categories in domestic production. Six accounts were created to record food consumption of households. These included: (1) staple food rice, (2) other cereals, (3) wheat flour, (4) vegetables, (5) meat, fish, milk and eggs, and (6) other foods. Transactions on fuel for lighting, cooking as well as operating vehicles and machinery at households were recorded in the energy account (7 energy: electricity, gas, fire wood and petroleum). Services consumed by households were recorded in the services account (8). Other day to day consumer items such as soap were recorded in the other consumer items (9). Given that households spent considerable amounts on recreation and ceremonies, these expenses were recorded in a separate account titled recreation and ceremony (10). The account for manufactured items (11) includes expenditure on items manufactured by local industries and enterprises. The output of crops and enterprises were recorded in another four accounts (12; paddy, 13; sugarcane, 14; banana, 15; OFC: Other Field Crops) and services produced by the construction workers were included in the construction account (16). Seed and cash inputs in agricultural production were recorded in the accounts of seed (17) and cash inputs (18). Seed accounts referred to the cost of family owned, or purchased planting materials, and the cash input included the expenses on fertilizer and other agrochemicals. All other expenditure items, which could not be included in any of the above categories, were included as other expenses (19). The other expenses mainly included the expenses on fixed and intermediate assets.

Institutions were divided into two groups which were households and government. Since this analysis does not focus on activities of firms, as the rural area of *Udawalawe* has only a few firms which are also stakes of large scale firms from rest of the country, firms were not separated into another account. Some other authors such as Adlemen *et al.* (1988) and Shiferaw and Holden (2000) have similarly not included firms in their regional SAMs for comparable reasons. With regards to households, they were disaggregated according to their per capita income and divided into ten separate income deciles (See Figure 3). Since there was no discernible separate local government for this smaller region and the national government was primarily responsible for financial allocations for all regions, the government account of this SAM essentially represents an insignificant fraction of national government relevant to this area. While government expenditures were estimated using consumption data and tax rates, government expenditure was estimated using data on transfer payments and subsidies. Government consumption is also not estimated mainly due to the limitations of data. Government transaction with rest of the world corresponds with the inflow and out flow of money to the region through national government.

The capital account represents the savings, long-term borrowings and investment in fixed and intermediate assets. The rest of the world account includes all the transactions that occur outside the regional economy (i.e. other regions of the country and other countries). Following the method suggested by Logfran and El-Said (1999) and the method used by Thobecke (1992), imports of goods and services, remittances, and income from and expenses for employment (in the rest of the country or other countries) were included in this ‘rest of the world’ account. Further, any transactions that were not recognized with our comprehensive database, such as operations of black market, were also treated as operations of rest of the world.

Using the accounting framework described above and accounts shown in Figure 3, a dummy table for a disaggregated SAM was prepared in Excel and the sub matrices to be completed were identified. The identified entries for the SAM were calculated in STATA by using the household level database and some secondary information gathered from government accounts and various other sources. Each cell entry was estimated as the total amount of transaction to that particular account by the entire population in the study area (region). Ratios of sample from each stratum (from the population) were used in estimating the population values from the sample.

Inconsistencies in this disaggregated SAM generated with primary data (as result of the bottom-up approach) were reconciled by using secondary data for the country and the region. The final reconciliation or the balancing of the SAM was carried out by the cross entropy method (Robinson *et al.*, 2001). A mathematical programme prepared in computer software GAMS, following a method developed by Robinson and El-Said (2000), was used for balancing of the SAM by equating all raw and column totals. A macro SAM for the region was produced by aggregating accounts in micro SAM (Table 2). It provides a comprehensive picture of the regional economy including the magnitude of the transactions between the main sectors of the economy.

Table 2. Macro SAM for the Regional Economy of Udawalawe Left Bank Region (2001-2002).

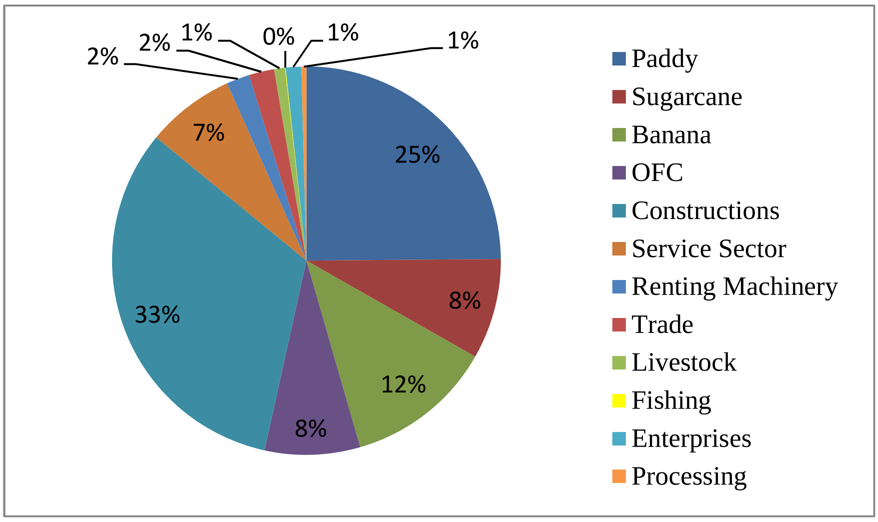
	Factors	Activities	Commodities	Households	Government	Capital	Rest of the world	**Total**
Factors	-	2,930.9	-	-	-	-	890.5	**3,821.5**
Activities	-	-	3,529.6	-	-	-	-	**3,529.6**
Commodities	-	289.8	-	2,770.5	-	-	2,304.3	**5,364.6**
Households	3,744.5	-	-	17.3	93.9	419.2	333.1	**4,607.9**
Government	-	31.4	22.5	4.7	-	-	93.9	**152.5**
Capital	-	-	-	357.4	-	-	419.2	**776.6**
Rest of the world	78.2	159.7	1,930.3	1,456.8	58.7	357.4	-	**4,041.0**
Total	**3,822.7**	**3,411.9**	**5,482.4**	**4,606.7**	**152.5**	**776.6**	**4,041.0**	**22,293.7**

Source: the Authors

Note: 1. Reference period - October 2001 to September 2002 (Maha 2001-02 and Yala 2002); The one year period was selected so that it covers two full agricultural seasons.
2. All values are in 2007 prices and in million rupees

While the macro SAM is suitable to provide an overall picture of the regional economy, the detailed micro SAM can be used for further elaboration. For example, the macro-SAM can be used in calculating the regional GDP and understanding the sectoral contributions to the GDP.

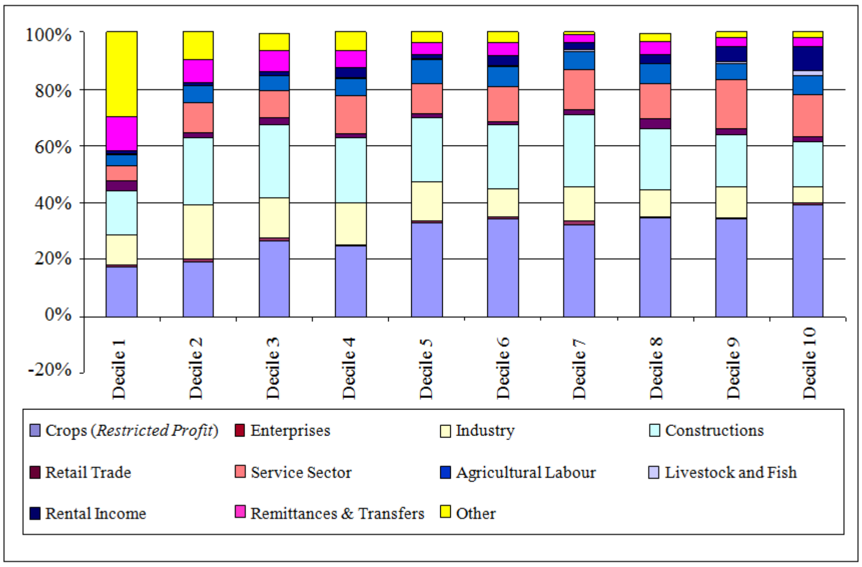
As shown in Figure 4, the direct contribution of the agriculture sector to the regional GDP through crop production was 53 percent. Livestock, and inland fisheries contributed to 1 and 0.05 percent of GDP respectively. Rental income and agro-processing at farm gate level contributed to another 3 percent of GDP and the construction sector induced by the development project contributed to 33 percent of GDP. As previously discussed, the construction sector mainly consists of employment income from irrigation canal construction, road construction and private and public building constructions. The service sector (made up of skilled workers) contributed to 7 percent of GDP. Per capita GDP in the regional economy is estimated at Rs 45,358.57 per annum and is only 47 percent of the national per capita GDP for the same year.



Source Data: Sub matrices 1,2 and 5,2 of the micro SAM

Figure 4. Sectoral Contribution to GDP.

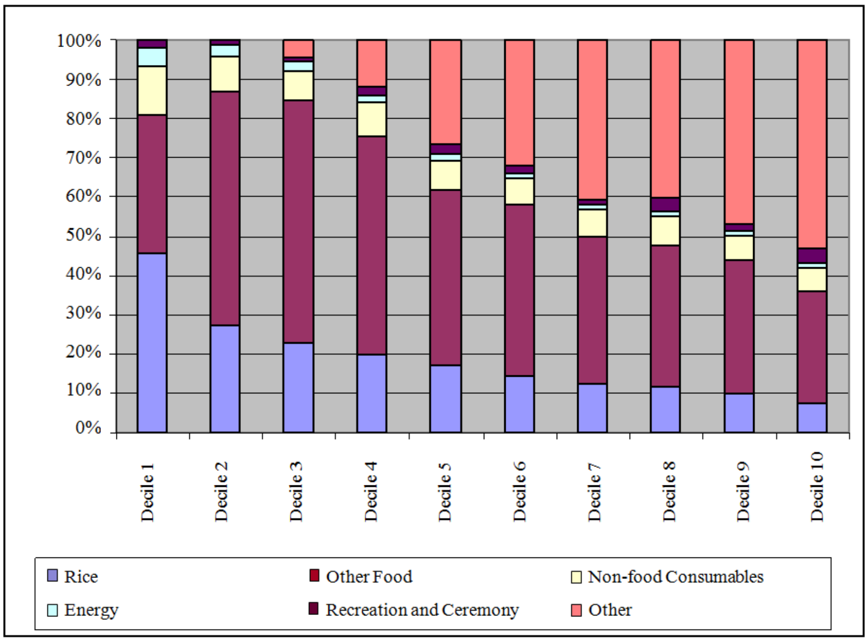
The average annual household income in the region can be calculated as the net return to factors of production. Based on this, it is estimated at Rs 148,019 per average household in the area. Micro SAM that classifies households according to the income deciles is useful in understanding the pattern of income distribution and main income generating activities of different income groups. As is depicted in Figure 5, the share of income as the gross profits from agriculture is high in richer deciles and low in poorer deciles. The share of income from transfers and other unclassified sources is high in lower income deciles.



Source Data: Sub matrices 4,1 4,4 4,5 4,6 4,7 of the micro SAM

Figure 5. Composition of Household Income (by income decile).

Analysis of household expenditure (by using the commodities household sub matrix) shows the consumption and expenditure pattern of the region. An average household spent 56 percent of its income on food items, 14 percent on staple food (e.g. rice) and 42 percent on other foods. Other day to day consumer items accounted for seven percent of the expenditure and other items of an average household account for 30 percent. The composition of household expenditure was also not uniform (Figure 6) among households. Lower income groups spent 80 percent of income on food while the richest groups spent less than 40 percent of income on the same items. The share of food expenditure on staple food (i.e. rice) for the lowest income group was more than 50 percent, while that of the richest income group was contrastingly less than 30 percent. The share of expenditure for purchasing of fixed and intermediate assets was also high in richer groups, while it was negligible within the poorest income groups.



Source Data: Sub matrix 3,4 of the micro SAM

Figure 6. Composition of Household Expenditure (by income decile).

The above descriptive analysis based on our regional SAM demonstrates a number of key features in a typical regional and rural economy in Sri Lanka. Firstly, a Sri Lankan rural regional economy is dominated by agricultural activities. Secondly, a new construction project induces a large flow of income to this rural economy by generating employment opportunities in construction related activities. Finally, a considerable proportion of total income in low income deciles is coming from transfers.

3. IMPACT ANALYSIS USING THE REGIONAL SAM

Even though a SAM itself is not an economic model, it can easily be transformed into an economic model by assuming that all relationships are linear and prices are fixed (at least for short run). This system can then be used to estimate multipliers that are useful in policy analysis. The SAM multiplier analysis gives an indication of the possible resultant effects of an exogenous shock on the functional (factorial) and institutional distributions of income as well as on the structure of output. Estimation of multipliers begins with classification of endogenous and exogenous accounts. Accounts of factors, activities, commodities and households are considered as endogenous accounts while accounts of government, capital and rest of the world are considered as exogenous. After classifying the accounts, the regional SAM can be represented in a matrix format as seen in Table 3. Transactions within endogenous accounts are represented by matrices T_{ij}. Endogenous expenditures into exogenous accounts (leakages) are represented by matrices L_{ij}. Exogenous expenditures into endogenous incomes are represented in matrices X_{ij} while exogenous expenditures into exogenous accounts (residuals) are represented in matrices $Z_{ij.}$

Table 3. A thematic SAM for Udawalawe Left Bank region

		1	2	3	4	5	6	7	
		Factors of Production	Production Activities	commodities	Households	Government	Capital Account	Rest of the World (RoW)	Total
1	Factors of Production		$T_{1,2}$					$X_{1,7}$	Y_1
2	Production Activities			$T_{2,3}$					Y_2
3	Commodities		$T_{3,2}$		$T_{3,4}$			$X_{3,7}$	Y_3
4	Households	$T_{4,1}$			$T_{4,4}$	$X_{4,5}$	$X_{4,6}$	$X_{4,7}$	Y_4
5	Government		$L_{5,2}$	$L_{5,3}$	$L_{5,4}$			$Z_{5,7}$	Y_5
6	Capital Account				$L_{6,4}$			$Z_{6,7}$	Y_6
7	Rest of the World (RoW)	$L_{7,1}$	$L_{7,2}$	$L_{7,3}$	$L_{7,4}$	$Z_{7,5}$	$Z_{7,6}$		Y_7
	Total	E_1	E_2	E_3	E_4	E_5	E_6	E_7	

Source: adapted from Shiferaw and Holden (2000), Stats (2005) and Wijerthna (2009)

To analyze multipliers concerning exogenous injections on endogenous accounts, all exogenous accounts are summed up horizontally. When average propensities of exogenous accounts to spend on endogenous accounts are given in a separate matrix, A_{ij}, the first four rows of above schematic matrix can be given with matrix algebra as follows.

$$\begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \end{bmatrix} = \begin{bmatrix} 0 & A_{12} & 0 & 0 \\ 0 & 0 & A_{23} & 0 \\ 0 & A_{32} & 0 & A_{34} \\ A_{41} & 0 & 0 & A_{41} \end{bmatrix} * \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \end{bmatrix} + \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix} \quad (1)$$

The reduced form of the above is

$$Y_n = (I - A_n)^{-1} X = M_a X \quad (2)$$

where $(I - A_n)^{-1}$ or M_a is the matrix of accounting multipliers.

Expression 2 shows how the effects of an exogenous injection on the income of endogenous accounts (Y_n) can be obtained by pre-multiplying the vector of exogenous income injections(x) by the accounting multiplier matrix (M_a), provided that M_a exists.

Following the method suggested by, Sadoulet and De Janvry（1995), multipliers calculated from the SAM are used in undertaking some policy experiments.

If Δ represents the operator “change,” and ΔX as the vector of shocks or exogenous interventions, the impact of those exogenous interventions on endogenous accounts can be given in vector ΔY. When matrix of SAM multipliers are given by $(I - A)^{-1}$, the vector of impacts is given by:

$$\Delta Y = (I - A_n)^{-1} \Delta X \quad (3)$$

Five illustrative policy experiments were carried out by simulating them as external shocks in the above model. We follow the procedure used by Sadoulet and Janvry (1995) to explain our experiments. The first four of the following experiments are related to possible policy interventions in regional development while the last one is related to possible negative impact of the closure of the project.

Experiment 1: The impact of irrigating all non-irrigated lands in the extension area.

Experiment 2: The impact of an increase in output and exports through increase in productivity of agriculture.

Experiment 3: The effects of a direct income transfer to the poorest three income deciles of households from any exogenous source to lift them up to the level just above the poverty line (PL).

Experiment 4: The effects of a re-distribution of income from highest three income deciles to lowest three income deciles so as to lift the lowest three deciles just above the PL.

Experiment 5: The effects of the closure of the project.

The above policy experiments were chosen to demonstrate the possibility of using the regional SAM in analysing some issues relevant to development both in *Udawalawe* in the Southern province and war-torn Northern and Eastern provinces. The first experiment was undertaken to analyse the impact of irrigating all possible non-irrigated lands in an agricultural area and to also understand the impact of the on-going project to irrigate all irrigable, but currently un-irrigated areas within the study area. Total direct impact of the intervention is estimated at the incremental value of net output of irrigated lands, compared to that of existing non irrigated lands. The second experiment explores the possibilities for increasing household income through an increase in output and exports of agriculture, by means of an improvement in productivity of agricultural sectors by 10 percent. This analysis was carried out to see the impact of possible productivity improvement, the variation among yield of farmers and estimated technical efficiencies on increasing agricultural output. This shock is performed with the assumption that (a) a 10 percent increase in productivity will result in a 10 percent increase in output of all crops and (b) all additional output can be exported to the rest of the world. Based on this, we use a 10 percent increase in export demand in this experiment as an indirect method to increase productivity since there are no productivity variables in this SAM model. In both cases, it was assumed that there were no supply and demand constraints or price variations. Assumptions of this nature are commonly applied in other I-O and SAM models.

The third experiment analyses the result of a cash transfer policy (from outside the regional economy) to increase the income of the three lowest income deciles up to the poverty line (using the national poverty line figure). This idea is consistent with the Sri Lankan government's attempts to lift low-socio economic groups out of poverty through central government transfer programmes. In other words, after gaining independence from the British in 1948, successive governments which have come to power in Sri Lanka have attempted to implement different kinds of social safety net programs to protect poor households for both political and economic reasons. The purpose of this third experiment policy shock was to therefore evaluate the impact of such a safety net program in terms of cash transfers. The value of the transfer payment was estimated by calculating the income gap between the last three deciles and the poverty line.

The purpose of the fourth experiment was to analyse the possible impact of boosting the poor with an income transfer programme within the region (i.e. income redistribution within the region). Although a transfer payment by the national government can protect the poor, it is a burden to the government and to the national economy. As such, it may be alternatively possible to do some income transfer within regional economies. This policy experiment thus has the purpose of analysing the impact of such a redistribution of income within the regional economy. In this case, the shock was calculated using the same methodology as the third experiment. Instead of providing cash transfer from an external source however, the income gap between the poverty line and the last three deciles is filled by transferring income from the three richest (8^{th}, 9^{th} and 10^{th}) deciles to the three poorest (1^{st}, 2^{nd} and 3^{rd}) deciles in the region.

The fifth and last experiment is used to understand the possible negative shock resulting from the end of a large investment project. The reverse of this is the positive temporary impact created by the project on this regional economy. The analysis of employment data shows that 60 percent of semi-skilled and unskilled labourers employed in the construction sector are likely to lose their income at the end of the project. The possible impact of this scenario is analysed in the last experiment by applying a shock of 60 percent decline in factor income from the construction sector.

Table 4 provides a summary of the results of all five policy experiments. According to the first policy experiment, the provision of

Table 4. Impact of Possible Pro-Poor Policy Interventions and Shocks on Production Activities Factor Income and Household Welfare

		Base value (Rs. Million –*2007 Prices*)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5
			Percentage change				
Factors	Land and family labour	282.64	4.75%	10.42%	0.03%	0.02%	-2.98%
	Land and family labour	48.93	3.39%	9.33%	0.02%	0.01%	-2.20%
	Land and family labour	303.83	11.81%	11.22%	0.05%	0.03%	-4.97%
	Land and family labour	771.97	11.99%	11.12%	0.05%	0.03%	-5.60%
	Land and family labour	34.77	17.99%	12.06%	0.09%	0.06%	-9.08%
	Skilled workers	1,960.97	0.56%	0.66%	0.01%	0.01%	-31.28%
	Unskilled workers	286.19	7.04%	10.89%	0.05%	0.03%	-5.44%
	Capital Assets (for rent)	132.17	4.01%	5.25%	0.02%	0.01%	-2.61%
Activities	Paddy	1,064.97	9.10%	12.29%	0.06%	0.04%	-6.22%
	Sugarcane	299.58	0.18%	10.19%	0.00%	0.00%	-0.09%
	Banana	445.96	13.53%	11.01%	0.02%	0.01%	-2.17%
	OFC	298.50	21.58%	13.05%	0.10%	0.06%	-9.65%
	Livestock	37.46	3.72%	4.18%	0.12%	0.05%	-15.07%
	Fishing	1.63	3.72%	4.18%	0.12%	0.05%	-15.07%
	Enterprises	37.81	3.63%	4.08%	0.13%	0.07%	-14.95%
	Processing	12.55	3.09%	3.44%	0.22%	0.18%	-13.22%
	Trade	93.80	3.51%	3.93%	0.15%	0.10%	-14.52%
	Constructions	962.45	0.00%	0.00%	0.00%	0.00%	-60.00%
	Service sector	218.10	4.37%	5.21%	0.10%	0.04%	-13.62%
	Renting machinery	56.77	9.33%	12.22%	0.06%	0.03%	-6.07%
Households (HH)	HH in 1st income decile	179.07	0.00%	-0.16%	0.75%	0.75%	-1.77%
	HH in 2nd income decile	240.61	2.16%	2.38%	0.49%	0.48%	-6.83%
	HH in 3rd income decile	245.58	2.58%	2.81%	0.36%	0.35%	-15.20%
	HH in 4th income decile	286.34	4.21%	4.65%	0.03%	0.01%	-16.45%
	HH in 5th income decile	342.54	3.74%	4.15%	0.02%	0.01%	-18.88%
	HH in 6th income decile	460.35	3.81%	4.40%	0.02%	0.01%	-17.93%
	HH in 7th income decile	508.44	4.26%	4.85%	0.03%	0.01%	-16.45%
	HH in 8th income decile	602.78	4.05%	4.65%	0.03%	-0.13%	-17.25%
	HH in 9th income decile	704.26	3.99%	4.49%	0.03%	-0.15%	-17.43%
	HH in 10th income decile	1,037.95	4.89%	5.51%	0.03%	-0.11%	-13.55%
	Gross Value of Production		6.90%	7.79%	0.04%	0.02%	-21.03%
	Factor Income		4.87%	5.47%	0.10%	0.01%	-15.24%
	Total HH income		3.88%	4.37%	0.03%	0.02%	-

Source: the Authors

irrigation water to all non-irrigated lands in the extension area can lead to an increase in output of paddy, banana and OFC sectors in the region by 9.10, 13.53 and 21.58 percent, respectively. This process increases the total gross value of production in the region by 6.90 percent and income of households by 3.88 percent. The level of output of other sectors is also expected to increase due to multiplier effects (as shown in Table 4). Since all the newly irrigated lands created by the intervention are going to be in the extension area, all incremental factor income on land and major parts of the incremental factor income earned by labour, should be accrued to the factors and consequently to the households within the extension area. As a result, the factor income in the regional economy is expected to increase by 4.87 percent. As shown in Table 4, the impact of this experiment will increase the income of all income deciles, except for the lowest one. This is mainly because the lowest income decile does not have land ownership. If this incremental income is equitably distributed among households in the extension area, existing high levels of poverty in the area (head count ratio of 50 percent as estimated by Wijerathna (2009)) can be totally eliminated with this intervention. The overall results of this experiment therefore demonstrate the importance of an irrigation project on a rural agricultural economy within a developing country.

The results of the second policy experiment suggest that the increase in productivity of all agricultural sectors by 10 percent will lead to an increase in output of agricultural sectors of more than 10 percent as a result of multiplier effects. Output of other sectors will also increase as result of the increase in demand for other products. This shock again leads to an increase in household income for all income deciles, with the exception of the lowest decile (see Table 4). It is also positive to note that the overall regional output increases by a notable 7.79 percent. If the same level of productivity improvement is achieved by all the farmers, the rich income deciles receive more benefits in comparison with the lower income deciles because of the land ownership of rich households. With the higher possibilities for efficiency improvement in lands of poor income deciles, a productivity improvement programme may be able to increase income in poor deciles at a higher rate, so that the poor will receive more benefits with the increase in net exports of the region resulting from productivity increase. Therefore, programmes that support an increase in net exports from agriculture by improving the efficiency of production are one of the possible pro-poor policy options which can work to reduce the existing poverty in this regional economy.

According to the results of the third experiment, income of poor households in the last three deciles increases by 0.75, 0.49 and 0.36 percent, respectively. As a result of multiplier effects, the other households also receive an average net increase in their income of between 0.02 and 0.03 percent. These outside transfers thus stimulate the whole economy and increase the output level of all production activities and sectors as a result of an increase in demand (see Table 4). It is also worth noting that the regional output increases in this case as well. This kind of cash transfer is only a temporary solution, as the government or any other external body has to bear an annual expenditure if this process is continued. Given this, the transferring of income from the top three income deciles to the bottom three income deciles may be a more suitable means of alleviating regional extreme poverty and redistributing income within the region itself. As described above, the fourth experiment is related to this type of re-distributional income policy. The results of this redistributive policy suggest that it is not as effective as the policy of external income transfers. As expected the rich income groups will lose and poor income groups will benefit from this policy. The overall regional output also only increases by a neglible 0.02 percent as a result of an increase in demand from lower income deciles. The output of production activities also experiences only a moderate increase under this policy scenario (see Table 4).

In order to finally analyse the possible income loss from the closure of the irrigation project, the fifth policy experiment was carried out. During the survey period the households in this regional economy received nearly 15 percent of their total income from construction activities stimulated by the construction project. It has been estimated that if this project were to close, a 60 percent decline in regional construction activities would result. On this basis, a 60 percent decline in factor income in the construction sector was introduced. The results shown in Table 4 demonstrate that this has an immense negative shock to the regional economy. That is, the regional output will decline by about 21 percent as a result of the closure of the project and all household income deciles are expected to lose (assuming that there are no compensatory policies). These results clearly demonstrate the important role that a new construction project plays in developing a rural regional economy. This is the reason why we argue that new construction projects are needed to revive war affected Northern and Eastern provinces and provide employment for the youth who took arms during the war.

4. CONCLUDING REMARKS

In this paper, an attempt was made to assess the appropriateness of applying the SAM technique to analyse the structure of a regional economy and to evaluate the impact of a large-scale project on a regional economy in Sri Lanka. The paper demonstrates that there are a number of advantages in developing a SAM for a rural economy in Sri Lanka. Firstly, a rural regional SAM is useful in better understanding the structure of the regional economy. Households in a rural agriculture-based economy act as the producers as well as the consumers and their economy is not necessarily similar to the national economy. Secondly, the adoption of a bottom up approach in the construction of a regional SAM, as opposed to following a top down approach starting from aggregated national accounts, is important in identifying the most relevant disaggregated accounts by considering the actual situation depicted by household data. The disaggregation of the household sector into deciles based on per capita income is important in understanding the inequality in distribution and analysing pro-poor policy interventions for convergence. The disaggregation of commodity accounts according to grass root level commodity demand is also useful in better understanding the structure of household expenditure. Thirdly, regional SAM-based multiplier models are useful tools in evaluating alternative regional development policies. Finally, the paper demonstrates that the SAM technique can be beneficial in evaluating the effects of new projects to be implemented in the North and East of Sri Lanka as part of the post-war development and reconciliation process.

Before concluding this paper it is important to note that although they are very useful in analysing the issues related to a regional economy, there are certain limitations of SAM based models. It is well-known that SAM models are based on a number of assumptions such as fixed prices, linear production functions and unitary elasticity's of demand. In other words, it is assumed that there are no supply side constraints and all prices are exogenous. These limitations can be eliminated by developing a regional CGE model based on SAM data (Devarajan and Robinson 2002). Finally it is recommended that future research undertake a Path-Analysis technique so that outcomes can be explained more explicitly. This task was beyond the scope of the current research.

Based on the study outcomes, this paper can be considered as the first step in compiling some disaggregated regional SAMs for Sri Lanka and using them in analysing sub-national level development issues. Development of similar SAMs for economically backward regions, including war torn areas, and building regional CGE models based on such newly developed SAMs will be important in analysing the appropriate policy interventions. Furthermore, until some regional level SAMs for other provinces are developed, the SAM for the *Udawalawe* region should be used as a proxy in understanding both the structure of similar agricultural economies and in analysing the impact of similar agricultural projects. Since both the Northern and Eastern provinces claim a vast potential for new irrigation development and agricultural projects, the kind of SAM developed in this study may be very useful in planning and analysing development policies for those areas.

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