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The Economic Effects of the Asian Tsunami on the "Tear Drop in the Indian Ocean": A General Equilibrium Analysis[1]

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1. Introduction

Sri Lanka was once known as "The Pearl of the Orient", "The Resplendent Isle", "The Garden of Aden" and "Paradise Isle". It had also been known as "The Tear Drop in the Indian Ocean". It has literally become the teardrop in the Indian Ocean since the Boxing Day tsunami, 26 December 2004. It is the second worst affected country by the Indian Ocean tsunami (IOT) in absolute terms after Indonesia and the most affected country in relative terms of per capita deaths, missing and displaced people. In addition to the damages to public infrastructure and owner-occupied houses, some sectors of the economy such as fishing and tourism have been severely affected. The international community has promised to provide a massive amount of foreign aid to reconstruct the country in addition to immediate relief efforts such as cleaning the affected areas and providing food, clothing, shelter and medicine.

Although it is difficult to evaluate the cost of lives, missing people and psychological trauma, it is possible to assess preliminary damages and financial needs to reconstruct the countries affected by the IOT. The main countries affected by the IOT have already been prepared these assessments in collaboration with international community (see for example, Central Government of Indonesia, 2005 for Indonesia and ADB, et al, 2005 for Sri Lanka). Although these reports have been prepared to estimate preliminary damages, they have not paid much attention to the direct and indirect economic effects of the tsunami and the demand effects of re-construction aid packages on economies such as Indonesia and Sri Lanka within an economy-wide framework. As the policy analysts have already indicated, the negative effects of IOT will largely be offset by the positive effects of reconstruction activities. For example, in its recently released annual report for 2004, the Central Bank of Sri Lanka has observed this as follows:

"Economic growth in 2005 has been revised downwards by about 0.5 – 1.0 per cent from the original estimate of 6.0 per cent, mainly due to disruptions to the fisheries and tourism sectors. However, the negative impact of these two sectors will largely be offset by the extensive reconstruction and rehabilitation activities planned for 2005." (Central Bank of Sri Lanka, 2005, p.4)

The positive demand stimulation effects may also pose some challenges to the macroeconomic management of economies. As indicated in a recent IMF "World Economic Outlook, April 2005", an increase in foreign aid and expenditure in the construction sector may cause a challenge in terms of macroeconomic management (IMF, 2005, p.14). A CGE model is ideally suited to capture the negative effects of IOT and the demand effects of reconstruction package together. In the past, single country CGE models have been used to examine the effects of natural disasters and diseases (see for example, Adams, et al, 2002, Horridge, et al, 2003 and Wittwer, et al, 2003). The main objective of this study, therefore, to attempt not only to examine the negative effects of the IOT but also to examine the possible effects of foreign aid on the Sri Lankan economy using a computable general equilibrium (CGE) model of the Sri Lankan economy. The next section of this paper provides a background for the paper. Section 3 provides a brief overview of the Sri Lankan CGE model. While section 4 describes the design of simulation experiments with the model, Section 5 analyses the results of policy simulations. The last section is devoted to the concluding remarks.

2. The Asian Tsunami and Sri Lanka

A massive earthquake of a magnitude of 9.0 on the Richter scale occurred off the east coast of Sumatra just before 8.00am local time (around 7.00am Sri Lankan time) on 26 December 2004. This triggered giant tidal waves that caused one of the worst natural disasters in the recent history. At least eleven countries in the Indian Ocean were affected by the Tsunami. Out of these eleven countries, Indonesia, Sri Lanka, India, Maldives and Thailand have been the most affected countries. According to reports, more than a quarter of a million dead or missing and more than a million have been displaced in the world. Five million people have been directly and indirectly affected by the IOT (see Table 1 for details). In addition to the human toll, a large

number of houses, hotels, schools and infrastructure were destroyed by the tsunami. The human costs and the psychological trauma cannot be measured. The preliminary costs of damages to five of the worst affected countries and financial needs to rebuild these countries have been estimated. The international organisations such as the ADB, World Bank and IMF and other donor countries have already promised to provide more than US $ 5 billion worth of foreign aid (see Table 2).

Table 1: The Human Casualties of the Indian Ocean Tsunami

Country	Dead	Missing	Displaced
Indonesia	94,000	132,000	603,518
Sri Lanka	30,957	5,644	474,619
India	10,881	5,792	502,456
Thailand	5,395	2,993	n/a
Somalia	150	n/a	5,000
Maldives	82	25	15,000
Malaysia	68	n/a	n/a
Myanmar	59	n/a	n/a
Tanzania	10	n/a	n/a
Seychelles	3	n/a	n/a
Bangladesh	2	n/a	n/a
Kenya	1	n/a	n/a

Sources: ADB, et al, (2005), Government of Indonesia (2005) and IMF (2005b).

Table2: The Economic Cost of Indian Ocean Tsunami and Aid Pledges for Reconstruction

Country	Damages		Real GDP Growth in 2005 (Projection in Percent)		Financial Needs and Aid Pledges (US$ Billion)	
	US$ Million	% of GDP	Pre-Tsunami	Post-Tsunami	Financial Needs	Aid Pledges
Indonesia	4,500	1.6	5.5	5.25 – 5.5	4- 5	3.955
Sri Lanka	1,000	4.5	6.0	5.3	1.5 – 1.6	0.308
Maldives	470	62.0	7.5	6.5	0.374	0.139
India	1,679	0.2	6.8	6.8	1.2	0.791
Thailand	500	0.3	5.9	5.6	1.5	0

Sources: IMF (2005), ADB, et al, (2005)

One and a half hours after the earthquake occurred off Sumatra, *Kalmunai* on the East coast of Sri Lanka was hit by the first massive tidal wave around 8.30am (Sri Lankan time). Following this, different parts of the country including the East, South, North

and the West of the island were hit by the IOT between 8.27am and 10.30am. As shown in Figure 1, more than two thirds or 1000 km of the coastal line of the island were severely damaged by the IOT. As shown by Figures 2 and 3 nearly 31,000 people have lost their lives, over 5000 people are reported to be missing and more than half a million people were displaced. More than one million people were directly or indirectly affected. These figures also show the district-wise distribution of death and missing people. Southern and Eastern provinces have been the worst affected areas. Table 3 further demonstrates the district-wise human cost of the economy.

Immediately after the IOT international donor organisations have prepared a report on "preliminary damage and needs assessment" as a basis for the 2005 post-tsunami recovery program in Sri Lanka (see ADB, et al, 2005). Following a methodology developed by the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC) for estimating the socio-economic and environmental impacts of disasters, this study has estimated asset losses, output losses, and the overall macroeconomic and fiscal effects. It has also estimated financial needs for the reconstruction program. Table 4 shows details of asset losses and financial needs reported in the study. According to Table 4, while the total damage of the IOT in Sri Lanka is estimated to be about $1 billion or 4.5 percent of Sri Lankan GDP, the total financial needs are estimated to be between $1.5 – 1.6 billion or 7.0 – 7.3 percent of GDP (Note that these numbers are different from other Sri Lankan sources. For example, the Central Bank of Sri Lanka (2005) notes that the total amount of financial needs is around $1.8 billion and Tittawella (2005), Chairman of TAFREN – Task Force for Rebuilding the Nation, notes that the total amount of financial needs is about $2-2.2 billion). Although the early estimate of reconstruction costs provided by the Sri Lankan sources was around $3.5 billion, multilateral donor organisations have downgraded this figure to around $1.5 - $1.6 billion. In terms of output losses, the most affected sectors are fishing and tourism. According to this study the economic growth of Sri Lanka in 2005 is expected to slowdown by about 1 percent. The Central Bank of Sri Lanka (2005) and the IMF (2005a) have also indicated that the Sri Lankan economic growth rate is expected to slowdown by a similar percentage in 2005. In the present study we attempt to examine the effects of IOT and the recovery package on the Sri Lankan economy within an economy-wide framework.

Table 3: Human Costs of Tsunami: Sri Lanka

As at 25th Jan 2005

Province	District	Impacts on lives								Impacts on properties		No. of camps
				Displaced persons								
		No. of affected families	No. of displaced families	In Welfare centers	With Relatives and friends	Total	No. of Deaths	No. of injured people	No. of missing people	No. o fully completely damaged houses	No. of partially damaged houses	
Northern	Jaffna	13,652	12,631	11,891	28,016	39,907	2,640	1,647	540	6,084	1,114	**
	Killinochchi	2,295	318	305	1,298	1,603	560	670	1	1,250	4,250	2
	Mulativu		6,007	11,993	10,564	22,557	3,000	2,590	552	3,400	600	23
Eastern	Trincomalee		27,746	19,559	62,084	81,643	1,078		337	5,974	10,394	42
	Batticaloa	63,717	12,494	30,403	31,509	61,912	2,840	2,375	1,033	15,939	5,665	48
	Ampara	38,624		75,172		75,172	10,436	120	876	29,077		81
Southern	Hambantota	16,994	3,334	555	17,168	17,723	4,500	361	963	2,303	1,744	5
	Matara	20,675	3,268	4,141	9,254	13,395	1,342	6,652	613	2,362	5,659	31
	Galle	23,174	1,472	4,830	123,247	128,077	4,216	313	554	5,525	5,966	40
Western	Kalutara	6,905	6,905	3,281	24,432	27,713	256	400	155	2,780	3,116	16
	Colombo	9,647	5,290	5,999	25,240	31,239	79	64	12	3,398	2,210	28
	Gampaha	6,827	308	876	573	1,499	6	3	5	292	307	2
North Western	Puttalam	232	18	66		66	4	1	3	23	72	2
Total		**202,742**	**79,791**	**169,071**	**333,385**	**502,456**	**30,957**	**15,196**	**5,644**	**78,407**	**41,097**	**320**

Source: Adopted from DCS (2005)

Table 4: Preliminary Estimates of Losses and Financing Needs ($ Millions)

Sector	Losses		Financial Needs		
	Asset Loss	**Output Loss******	**Short Term**	**Medium Term**	**Total Needs**
Housing	306-341	-	50	387-437	437-487
Roads	60	-	25	175	200
Water and Sanitation	42	-	64	53	117
Railways	15	-	40	90	130
Education	26	-	13	32	45
Health	60	-	17	67	84
Agriculture*	3	-	2	2	4
Fisheries*	97	200	69	49	118
Tourism*	250	130	130	-	130
Power	10	-	27	40-50	67-77
Environment	10	-	6	12	18
Social Welfare**	-	-	30	-	30
Excluded Items plus	90		30	120	150
Contingency***					
Total ($ Millions, rounded)	**970-1,000**	**330**	**500**	**1,000-1,100**	**1,500-1600**
Percent of GDP	**4.4-4.6**	**1.5**			**7.0-7.3**

* Includes estimates from livelihood damages assessment of fishermen, small farmers, and small businesses in tourism totalling $140 million.
** Targeted assistance to vulnerable groups
*** Includes items mentioned in the report

**** Refer to 2005 and 2006.

Source: Adopted from ADB, et al (2005)

3. A Brief Overview of the CGE Model of the Sri Lankan Economy

Sri Lanka has a long history of applying CGE models in analysing various issues related to the economy. The availability of quality data has been one of the main reasons for this trend. In fact, Sri Lanka is the first developing country for which a Social Accounting Matrix (SAM) was developed in the early 1970's (Pyatt and Roe, 1977). This has influenced the wide adoption of CGE framework in economic policy analysis of the country. De Melo (1978) developed the pioneering CGE model for Sri Lanka. Since then, several studies have developed CGE models for the Sri Lankan economy[2]. Bandara (1989) developed the first CGE model of the Johansen class (with linearized system of equations) following the ORANI model (Dixon et al, 1982) of

[2] See Blitzer & Eckaus (1986); Jayawardena *et al*, (1987); Bandara (1989); CIE (1992); Herath (1994); Somaratne (1998); Bandara & Coxhead (1999); Kandiah (1999).
For a comprehensive survey of CGE applications for the Sri Lankan economy see Bandara (1990).

the Australian economy. As an extension to the ORANI tradition of Sri Lankan CGE modelling Naranpanawa (2003) developed a CGE model for the Sri Lankan economy to incorporate income distribution and poverty following the IDCGEM model of the South African economy. We used this model to examine the effects of IOT and the reconstruction package on the Sri Lankan economy.

The core component of the Sri Lankan CGE model developed by Naranpanawa (2003) follow the previous CGE models, which were based on the Australian ORANI model (Dixon, et al, 1982) and the IDCGEM model (Horridge, et al., 1995). Similar to its predecessors, most of the behavioural equations of the core model of the present Sri Lankan model are derived on the basis of neo-classical utility maximisation and profit maximisation assumptions. They:

- Describe household and other final demands for commodities;
- Describe industry demand for primary factors and for intermediate inputs from domestic and imported sources;
- Ensure zero-pure profit conditions, that is, the prices of commodities reflect costs of production;
- Ensure market clearance;
- Relate producer prices paid by purchasers;
- Describe income distribution of households;
- Describe government income and expenditure sides and
- Define key macroeconomic identities.

All equations in the model can be grouped into a number of blocks as shown in Table 5 (we do not present technical details of the model since they are similar to any ORANI type model).

Table 5: Main blocks of Equations in the Model

Block	Equations
Block 1:	**Demands Industry Inputs**
	Intermediate inputs (domestic and imported)
	Primary factors
	Labour by occupation
	Production subsidies
Block 2:	**Final Demands for Commodities**
	Demand for capital creation
	Household demands
	Exports
	Government demand
Block 3:	**Zero Pure Profits Conditions**
	Production
	Capital creation
	Importing
	Exporting
	Distribution
Block 4:	**Investment Allocation**
	Distribution of investment
	Investment budget constraint
Block 5:	**Market-Clearing Equations**
	Domestically produced commodities
	Imported commodities
	Primary factors
Block 6:	**Balance of Trade**
	Imports
	Exports
	Balance of trade
Block 7:	**Income Distribution**
	Firm's income
	Household income
	Government income
Block 8:	**Miscellaneous Equations**

The equation system of the model closely follows the IDCGEM model, which belongs to the well-known Johansen class (Johansen, 1960). Following the Johansen method, all variables in the model are shown in percentage change forms. It is important to note here that all simulations carried out with this model are comparative-static simulations, ie, they are concerned with questions of how different the economy would be with and without the shocks under consideration. The well-known GEMPACK software is used to solve the model (see for details, Harrison and Pearson, 1998). To implement the model, we have developed a Social Accounting Matrix (SAM) developed for Sri Lanka for the year 1995.

4. Design of Experiments: The Effects of Tsunami and the Possible Effects of the Aid Package

In this study we decided to conduct two sets of simulations to carry out with the Sri Lankan CGE model. The first set of simulations is carried out to examine the effects of IOT on macroeconomic variables and industry output level. The second set of simulations is carried out to examine the demand effects of the reconstruction aid package. In order to design a set of experiments for this study, we use information available in recent studies on preliminary estimation of damages and financial needs for reconstruction and make certain assumption where necessary. As indicated in the recent study on damages of IOT in the Sri Lankan economy (ADB, et al, 2005), asset losses (about 4.4 – 4.6% of GDP) are much higher than the output losses (about 1.5% of GDP). The most affected are the fishing and tourism. According to recent estimates two thirds of the fishing boats has been destroyed a decline demand for tourism by 15 percent is expected. Many sectors such as hotels, trade, transport and telecommunication have been affected by the IOT. In the present model there is a separate sector for fishing. However, there is no separate sector for tourism and the activities of tourism are related to hotels, trade, transport, and communication sectors. On the basis of model specification and available preliminary information we decided use the following shocks to examine the effects of IOT on macro variables and industry output levels:

1. a 65% of reduction in capital stock in the fishing industry;
2. a 15% reduction of demand for tourism;

3. a 10% reduction in capital stock in dwellings; and
4. a 2 % reduction in efficiency in trade and transport sectors.

On the other hand we decided to use a set of experiments to examine the demand effects of the reconstruction aid package. A relatively simple approach to modelling the effects of increase in foreign capital inflows is to treat the amount of capital inflows as a "free gift" of foreign currency for the economy and introduce the shock via the balance of trade variable in the model, allowing the economy to increase its balance of trade deficit by an amount equivalent to the change in foreign aid after the IOT. As the IMF (2005b) note that Sri Lanka will receive around US$ 500 million (around Rs. 50,000 million) as foreign aid in 2005 for reconstruction. In this study we treat this as a "gift" and allow balance of trade deficit to increase in order to absorb this gift. It is also expected to increase demand for construction activities in the economy. Therefore, an experiment is carried out with a 10 percent increase demand for construction in this study.

In order to perform the above simulations, a set of assumptions is used to close the model. It is important to provide the main features of the closure or economic environment used in this study briefly. The assumptions used in the closure of current model can briefly be described as follows:

- The "small country" assumption is made in this closure by treating world prices of imports as exogenous.
- The physical capital stock is fixed in each industry (except for the construction sector). Hence the results of simulations with the model are short-run.
- Aggregate employment is fixed (exogenously given) and the aggregate real wage rate is determined endogenously. Then, the model projects the change in the aggregate real wage rate which is consistent with the given level of aggregate employment.
- The nominal exchange rate is fixed and it acts as a *numeraire*. Therefore, changes in domestic price indices are to be interpreted as changes in domestic prices relative to world prices.

- The balance of trade is fixed. Since the change in the balance of trade is set at zero, the model indicates the change in real absorption, which would be required to accompany a given level of the balance of trade deficit or surplus. Hence, real absorption is endogenous in this model.

5. The Results of Simulations

In this section, we present the results of the simulations described in the previous section. The projected macroeconomic effects of the simulations related to the costs of IOT are shown in Table 6. The total effects of the IOT are shown in the last column of Table 6. It shows that the real GDP declines by about 2.1 and the consumer price index is projected to increase by 3.98 percent. Real aggregate consumption is also projected to decline around 3 percent. Since the balance of trade is fixed in this closure, both export and import volumes are expected to decline. It can be observed from Table 6 that the macroeconomic impacts of IOT are dominated primarily by the reduction in capital stock in the fishing sector. In line with other assessments of IOT, the fishing sector is the mostly affected sector in the Sri Lankan economy since two thirds of the coastal area was hit by the waves. It directly contributes around 2 percent to GDP in the economy. As expected, the macreconomic impacts demonstrate that the there are some negative impacts on the economy in terms of real GDP, household consumption and consumer price index.

Table 7 presents the projected sectoral impact of IOT. The results shown in table 7 indicate that the destruction of the capital stock in the fishing sector is projected to reduce the output of fishing by about 19 percent. When we look at the projected changes in output levels of some related sectors such as other agricultures, paper and paper products, basic metals, and hotels and restaurants, it is clear that their negative output responses are related to the negative effects of fishing sector.

So far we examined the effects of IOT on the Sri Lankan economy in isolation. As noted earlier, many donor countries and global organisations pledged a large amount of foreign aid to Sri Lanka immediately after the IOT. Therefore, many observers believe that the negative impact of IOT will be offset by the effects of foreign aid flows. To capture this aspect, the effects of an increase in aid were simulated with the

model in a relatively simple way via the balance of trade variable giving the economy a `free' gift of foreign exchange representing an increase in foreign capital in flows as noted in the previous section. We have also increased the demand for construction by 10 percent in order to capture increasing activities in the construction sector.

The projections of the above experiments together with the effects of the IOT experiments on macroeconomic variables are presented in Table 8. This table also presents projections of combined effects of the IOT and the recovery package. In contrast to the effects of IOT experiments, an increase in domestic absorption is required to accommodate a large flow of foreign aid. Since aggregate employment and capital stocks are fixed in the closure of our model, an increase in imports and /or a decline in exports are necessary parts of the adjustment of domestic absorption to accommodate an increase in foreign aid. According to the results shown in Column nine of Table 8, the aggregate export volume is projected to decline by about 29 percent and the aggregate import volume is projected to increase by 12 percent. The economy has the capacity to increase its imports relative to its exports as a result of an increase in foreign aid. The above trade results are reflected in higher domestic absorption. The increased domestic demand creates upward pressure on domestic prices as reflected in the projected results of the consumer price index (an increase of 17 percent).

We now turn to the results of sectoral projections of an increase in foreign aid. These projections are shown in column nine of Table 9. The industry specific results can be explained by using some key features. Many export industries are projected to affect and some non-tradeable industries are projected to expand.

Table 6: The effects of Tsunami: Projections of percentage changes in macro variables

Macro Variable	2% reduction of productivity in the Trade sector	2% reduction of productivity in the transport sector	15 % reduction in demand for trade	15% reduction in demand for transport	65% reduction in capital stock in the fishing sector	10% decline in capital stock of Dwellings	Total Effects
Real Wages (*f1lab_io*)	-0.26	0.02	-0.09	0.03	-9.75	-1.9	-12.01
Real GDP (*x0gdpexp*)	-0.41	-0.24	0	-0.01	-1.32	-0.12	-2.1
Real Devaluation (*p0realdev*)	0.36	0.32	0.27	0.11	-0.54	-1.88	-1.36
Consumer Price Index (*p3tot_h*)	-0.46	-0.39	-0.2	-0.13	2.44	2.72	3.98
Import Volume Index, CIF Weights (*x0cif_c*)	-0.33	-0.37	-0.03	-0.04	-2.35	0.29	-2.83
Export Volume Index (*x4tot*)	-0.08	-0.24	0.19	0.05	-2.87	-0.58	-3.58
Aggregate real household consumption (*x3tot_h*)	-0.54	-0.58	-0.09	-0.07	-2.06	0.27	-3.07

Table 7 : Projections of percentage changes in output level of different industries

Industry	Decrease in productivity in the trade sector by 2%	Decrease in productivity in the transport sector	Decrease in demand for trade by 15%	Decrease in demand for Transport by 15%	Decrease in capital stock in the fishing sector	Decrease in demand capital stock in Dwellings by 10%
Tea Growing	0.32	0.16	0.15	0.08	3.48	-0.92
Rubber Growing	0.21	0.11	0.11	0.05	2.38	-0.66
Coconut Growing	0.09	0.01	0.06	0.03	0.57	-0.94
Paddy	-0.06	-0.09	0.01	0	0.18	0.13
Minor Export Crops	0.02	0.01	0.01	0	0.23	-0.01
Tobacco	0.07	0.02	0.05	0.02	0.94	-0.04
Other Agriculture	-0.05	-0.07	0	-0.01	-0.41	0.08
Livestock	-0.06	-0.09	0.01	0	-0.05	0.05
Firewood	-0.09	-0.12	-0.01	-0.02	-0.2	0.17
Forestry	0.02	-0.02	0.03	0.01	0.24	-0.01
Fisheries	0.06	0.01	0.02	0.01	-18.97	0
Mining and Quarrying	0.15	0.07	0.07	0.02	1.86	-0.07
Tea Processing	0.24	0.07	0.15	0.06	3.38	0.48
Rubber Processing	0.11	0	0.1	0.03	2.31	1.05
Coconut Processing	0.3	0.12	0.19	0.08	5.04	0.91
Milling	-0.06	-0.09	0.01	0	0.18	0.13
Food, Beverages and Other	0.03	0	0.02	0.01	-0.22	0
Textiles	0.04	0	0.18	0.07	2.17	-0.03
Garments	0.26	0.14	0.13	0.07	2.93	-0.16
Wood & Wood Products	0.04	0	0.04	0.02	0.89	-0.02
Paper & Paper Products	-0.15	-0.03	0.16	0.09	-15.54	-0.02
Chemicals and Fertilisers	-0.37	-0.46	-0.01	-0.02	-2.45	0.28
Petroleum	-0.22	-0.16	0.04	0.02	-4.57	-0.03
Plastic and Rubber Products	0.05	0	0.05	0.02	0.78	0
Non Metalic & Other Mineral Products	0.1	0.03	0.08	0.04	1.3	-0.04
Basic Metal Products	0.35	0.22	0.21	0.09	-7.04	-0.11

Contd …

Fabricated Metal Products	0.07	0	0.08	0.03	1.13	-0.05
Other Manufacturing	0.05	-0.03	0.11	0.05	1.56	-0.02
Electricity, Gas and Water	-0.35	-0.12	-0.02	0	0.31	0.06
Construction	-0.04	-0.05	0	-0.01	0.16	0.53
Wholesale and Retail Trade	-2.1	0.07	-0.18	0.03	2.41	-0.08
Hotels and Restaurants	-0.47	-0.49	-0.08	-0.07	-3.49	0.12
Transport	0.09	-2.07	0.06	-0.17	1.67	-0.02
Post and Communication	-0.48	-0.57	-0.04	-0.05	0.71	0.43
Banking Insurance and Real Estate	0.19	0.26	0.15	0.07	-16.18	-0.01
Ownership of Dwellings	0	0	0	0	0	-10
Public Administration and Defence	0.04	0.03	0.01	0.01	-0.94	0
Other Personal Services	-0.49	-0.74	-0.07	-0.08	-0.28	0.49

Table 8: The combined effects of IOT and recovery package: Projections of percentage changes in macro variables

Macro Variable	Combined effects of IOT and recover package	2% decline in productivity in the trade sector	2% decline in productivity in the transport sector	Decrease in demand for trade by 15%	Decrease demand for transport by 15%	Decrease in capital stock in the fishing sector by 65%	Decrease in capital stock in dwellings by 10%	Increase in balance of trade deficit by 10%	Increase in construction demand by 10%
Real Wages (*f1lab_io*)	-20.68	-0.26	0.02	-0.09	0.03	-9.75	-1.9	-8.33	-0.4
Real GDP (*x0gdpexp*)	0.29	-0.41	-0.24	0	-0.01	-1.32	-0.12	2.26	0.13
Real Devaluation (*p0realdev*)	-14.58	0.36	0.32	0.27	0.11	-0.54	-1.88	-13.12	-0.11
Consumer Price Index (*p3tot_h*)	21.51	-0.46	-0.39	-0.2	-0.13	2.44	2.72	17.34	0.19
Import Volume Index, CIF Weights (*x0cif_c*)	9.42	-0.33	-0.37	-0.03	-0.04	-2.35	0.29	12.32	-0.06
Export Volume Index (*x4tot*)	-25.57	-0.08	-0.24	0.19	0.05	-2.87	-0.58	-21.86	-0.18
Aggregate real household consumption (*x3tot_h*)	18.3	-0.54	-0.58	-0.09	-0.07	-2.06	0.27	21.07	0.3

Table 9: The combined effects: Projections of percentages in industry output level

Industry	Combined effects of IOT and recover package	2% decline in productivity in the trade sector	2% decline in productivity in the transport sector	Decrease in demand for trade by 15%	Decrease demand for transport by 15%	Decrease in capital stock in the fishing sector by 65%	Decrease in capital stock in dwellings by 10%	Increase in balance of trade deficit by 10%	Increase in construction demand by 10%
Tea Growing	-1.53	0.32	0.16	0.15	0.08	3.48	-0.92	-4.82	0.02
Rubber Growing	-1.11	0.21	0.11	0.11	0.05	2.38	-0.66	-3.32	0
Coconut Growing	0.53	0.09	0.01	0.06	0.03	0.57	-0.94	0.67	0.04
Paddy	3.81	-0.06	-0.09	0.01	0	0.18	0.13	3.62	0.03
Minor Export Crops	0.09	0.02	0.01	0.01	0	0.23	-0.01	-0.18	0.01
Tobacco	0.14	0.07	0.02	0.05	0.02	0.94	-0.04	-0.94	0.02
Other Agriculture	2.59	-0.05	-0.07	0	-0.01	-0.41	0.08	2.98	0.07
Livestock	3.38	-0.06	-0.09	0.01	0	-0.05	0.05	3.47	0.07
Firewood	4.5	-0.09	-0.12	-0.01	-0.02	-0.2	0.17	4.66	0.1
Forestry	1.6	0.02	-0.02	0.03	0.01	0.24	-0.01	0.97	0.34
Fisheries	-18.56	0.06	0.01	0.02	0.01	-18.97	0	0.27	0.05
Mining and Quarrying	0.58	0.15	0.07	0.07	0.02	1.86	-0.07	-1.59	0.06
Tea Processing	2.44	0.24	0.07	0.15	0.06	3.38	0.48	-2.1	0.17
Rubber Processing	3.7	0.11	0	0.1	0.03	2.31	1.05	-0.08	0.19

Contd …

Coconut Processing	1.61	0.3	0.12	0.19	0.08	5.04	0.91	-5.24	0.2
Milling	3.81	-0.06	-0.09	0.01	0	0.18	0.13	3.62	0.03
Food, Beverages and Other	-0.02	0.03	0	0.02	0.01	-0.22	0	0.14	0.02
Textiles	1.55	0.04	0	0.18	0.07	2.17	-0.03	-0.92	0.05
Garments	-1.81	0.26	0.14	0.13	0.07	2.93	-0.16	-5.19	0.03
Wood & Wood Products	0.97	0.04	0	0.04	0.02	0.89	-0.02	-0.08	0.07
Paper & Paper Products	-16.58	-0.15	-0.03	0.16	0.09	-15.54	-0.02	0.96	-2.06
Chemicals and Fertilisers	13.31	-0.37	-0.46	-0.01	-0.02	-2.45	0.28	15.77	0.57
Petroleum	-7.59	-0.22	-0.16	0.04	0.02	-4.57	-0.03	-1.98	-0.68
Plastic and Rubber Products	0.15	0.05	0	0.05	0.02	0.78	0	-0.78	0.02
Non Metalic & Other Mineral Products	0.09	0.1	0.03	0.08	0.04	1.3	-0.04	-1.61	0.19
Basic Metal Products	-13	0.35	0.22	0.21	0.09	-7.04	-0.11	-8.4	1.68
Fabricated Metal Products	0.24	0.07	0	0.08	0.03	1.13	-0.05	-1.06	0.03
Other Manufacturing	1.42	0.05	-0.03	0.11	0.05	1.56	-0.02	-0.36	0.06
Electricity, Gas and Water	3.7	-0.35	-0.12	-0.02	0	0.31	0.06	3.85	-0.04
Construction	11.14	-0.04	-0.05	0	-0.01	0.16	0.53	1.53	9.03

Contd …

Wholesale and Retail Trade	-1.47	-2.1	0.07	-0.18	0.03	2.41	-0.08	-1.76	0.13
Hotels and Restaurants	13.36	-0.47	-0.49	-0.08	-0.07	-3.49	0.12	17.44	0.39
Transport	-0.61	0.09	-2.07	0.06	-0.17	1.67	-0.02	-0.2	0.04
Post and Communication	20.2	-0.48	-0.57	-0.04	-0.05	0.71	0.43	21.38	-1.17
Banking Insurance and Real Estate	-21.51	0.19	0.26	0.15	0.07	-16.18	-0.01	-6.11	0.12
Ownership of Dwellings	-10	0	0	0	0	0	-10	0	0
Public Administration and Defence	-9.33	0.04	0.03	0.01	0.01	-0.94	0	-0.86	-7.62
Other Personal Services	20.79	-0.49	-0.74	-0.07	-0.08	-0.28	0.49	21.91	0.05

6. Concluding Remarks

The results of our study demonstrate how a CGE model can provide some information on the effects of IOT and on the likely effects of a reconstruction aid package on tsunami affected economies such as Sri Lanka, India and Indonesia. However, our results should be used with caution. It is important to note that among other things, the value of our CGE modelling exercise is limited by the assumptions made, the magnitudes of shocks (or values use for simulations), quality of the database (SAM database and the elasticity parameters) used and the closure used in the study. Particularly, the results should be approached with a sceptical attitude to the database. Sri Lanka has a poor record in input-output and SAM databases in comparison to many other developing countries. We developed a SAM database using some primary information since there are no properly compiled input-output tables or SAM databases for recent years. Therefore, the results shown in the previous sections should be treated as an empirical guidance rather than precise values of changes in different variables.

The results our modelling exercise indicate that it is important to consider the combine effects of the IOT and the reconstruction package. While the IOT has produced negative economic effects on the economy, the reconstruction package would stimulate the economy. These results support the current view expressed in Central Bank of Sri Lanka (2005) and the IMF (2005b).

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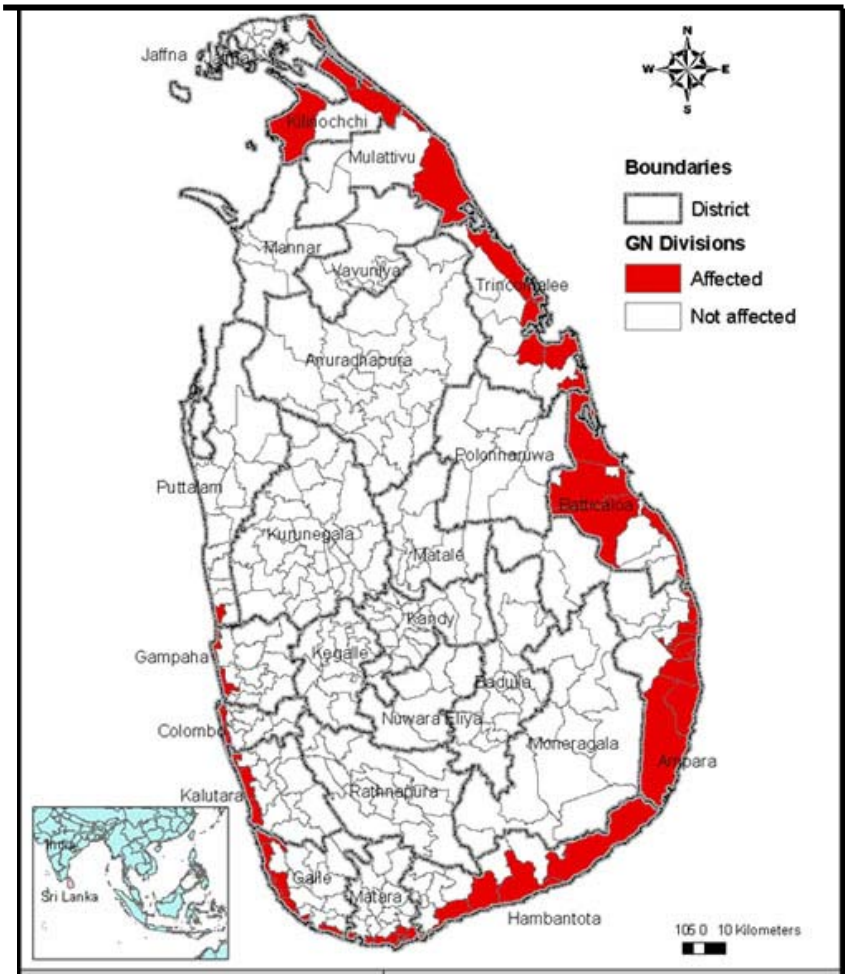
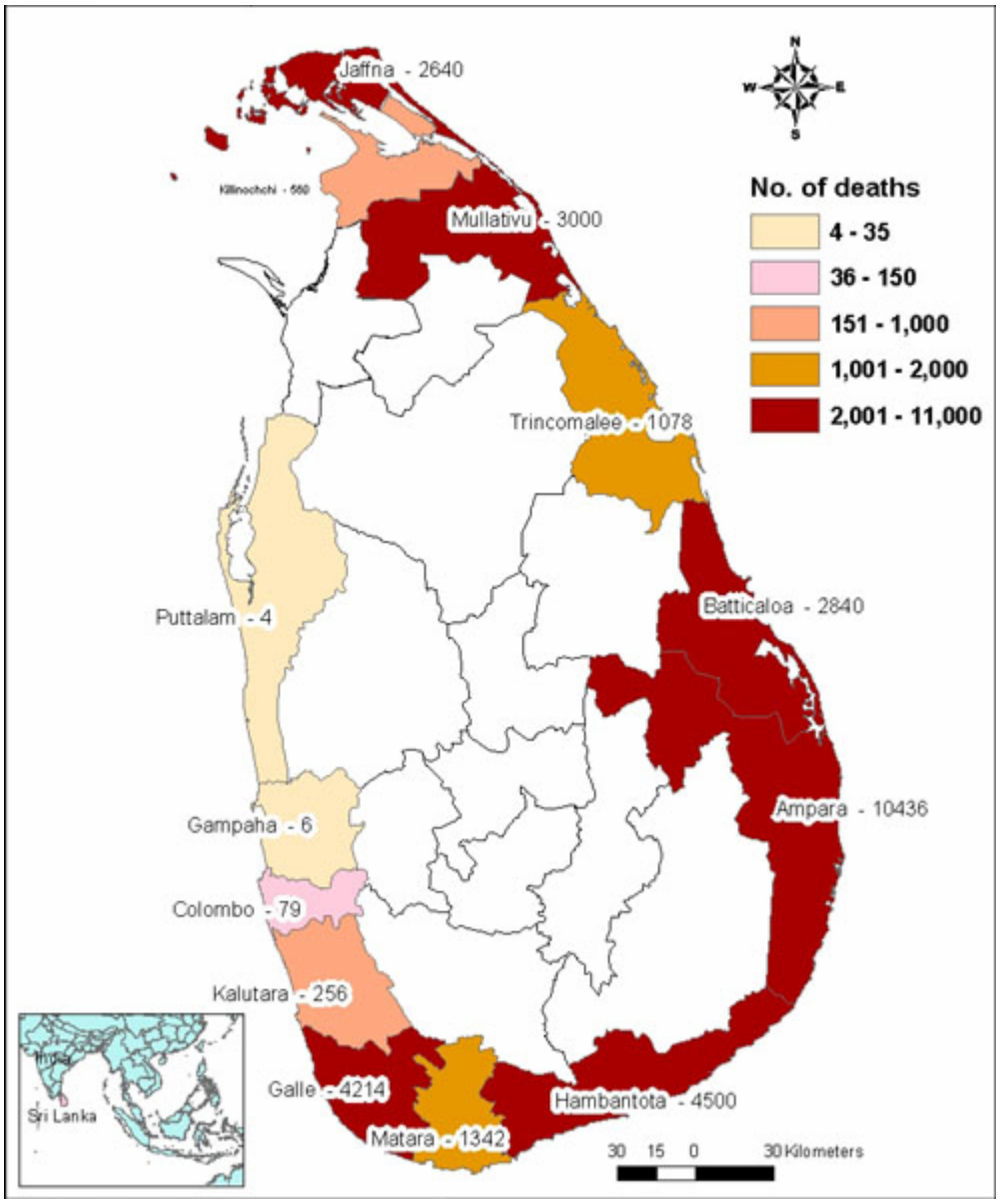
Figure 1: Tsunami Affected Areas in Sri Lanka



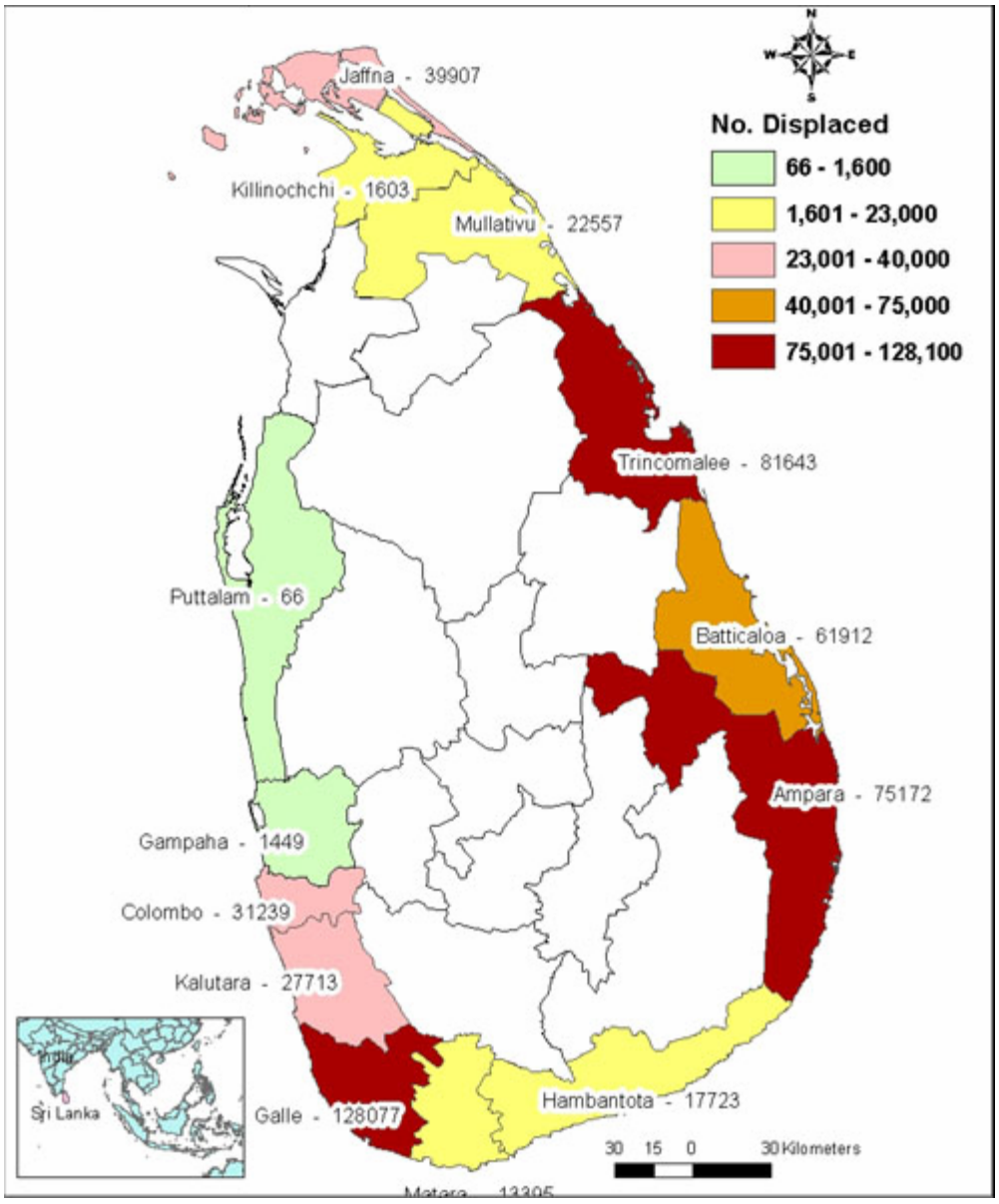
Source: Adopted from DCS (2005)

Figure 2: District-wise Distribution of Tsunami Deaths in Sri Lanka



Source: Adopted from DCS (2005)

Figure 3: District-wise Distribution of Number of Displaced People in Sri Lanka as a Result of IOT



Source: Adopted from DCS (2005)