Recuperation of economy after volcanic eruption in Mt. Merapi, Indonesia: a multiregional input-output analysis

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Abstract

Indonesia is in one of the disaster-prone points, the ring of fire, which frequently suffer from natural disasters. Mt. Merapi volcanic eruption in 2010 was one of the catastrophic natural disasters, which caused the approximate economic damages of 3,628 trillion Indonesian rupiah. To recover the loss of different sectors of the economy, the central and regional governments allocates special budget for recovery and reconstruction. We assess the induced economic effects of Mt. Merapi eruption recovery fiscal support by using a multiregional input-output (MRIO) model. We utilize the state level data of the 2005 Indonesian interregional input-output table (IRIO) and the 2011–2013 volcano eruption restoration. Our results indicate that the effect of 2010 recovery budget for Mt. Merapi eruption contributed to the economy of the hazard-affected Yogyakarta Special Region. In addition, the forestry sector, other services sector, and construction sectors have a significantly benefited from the induced output by fiscal support.

1. Introduction

The ring of fire is one of the most natural disaster hotspots in the basin of the Pacific Ocean. The region formed 40,000 km (25,000 miles) horseshoe-shaped basin from South America to North America through New Zealand to the Bearing Strait, Japan. There are frequent occurrences of various kinds of disasters, such as earthquakes, tsunamis, volcanic eruptions, floods, droughts, landslides, and forest fires. There are 452 volcanoes through the ring of fire length, 75% of which are inactive (De Boer & Sanders, 2012).

Indonesia is located in the ring of fire region with the world's most active volcanoes (United Nations, 1982). In this island nation, the number of volcanoes is around 147, of which 76 are active. The volcanoes are scattered along the Sumatra, Java, Celebes, and the Lesser Sunda islands. The volcanic eruption is one of the most alarming disaster in Indonesia and this eruption further tracked by massive damage to infrastructure and shifts in social organizations as well as long-term financial impact (United Nations, 1982).

In Indonesia, the contemporary and one of the most devastating volcanic eruption, named as the Mt. Merapi eruption, occurred on October 26, 2010 and continued until November 2010. The eruption event results in the loss the massive damage of lives and property. The disaster subsequently designated as a catastrophic natural disaster. The damage caused by Mt. Merapi eruption had an impact on the residential sector, infrastructure, social, economic, across-sector, which resulted in the disruption of public activities and services in the area around Mt. Merapi.

Based on the appraisal results of the Regional Disaster Management Agency, Yogyakarta Special Region Province, the eruption of Mt. Merapi has caused damage and losses of 3,628 Trillion rupiah (Faturay, Lenzen, & Nugraha, 2017). Moreover, Regional Disaster Management Agency of Yogyakarta Special Region (Faturay et al., 2017) explained that as the impact of damage and losses exist long, the estimated total government particular budget, both central and local government, requirements for rehabilitation

and reconstruction after the disaster of Mt. Merapi eruption in Yogyakarta Special Region Province amounted to 772.90 billion rupiah. This particular total budget allocated from 2011 to 2013.

Given Indonesia's geographical appraise and economic varying qualities, it is fundamental that economic, social, and natural assessments make utilize of regionally abrasive and comprehensive information. Therefore, it is necessary to estimate the induced output effect from the recuperation budget of the post-Mt. Merapi eruption and its interaction with other provinces and sectors in Indonesia using the multi-regional input-output (MRIO) table of Indonesia 2005. The MRIO assessment as a helpful instrument for multi-regional and multi-sectoral effect assessment can define the regions as provinces and industries that play a key role in other fields and sections or in the financial structure of Indonesia. The MRIO model is implied in this research in estimating the induced impact of the specific government budget on the eruption of Mt. Merapi's rehabilitation and reconstruction (recovery).

Several earlier studies focus on the analysis of the catastrophe using the input-output model (i.e. Koks and Thissen, 2016; Li et al., 2013; Hallegatte, 2008), mostly assessing short-term or long-term disaster damage and losses. Koks and Thissen (2016) explained that most of the neighboring regions gain from the flood due to increased demand for reconstruction in the affected region. In other words, around 25% of the total increase in production is caused by disaster import which is the direct increase in production demand for the non-affected regions. Meanwhile Li et al., (2013) in their paper mentioned London’s economy would recover approximately 70 months by applying some proportion ratio scheme assumption. Policies in transportation and health care are effective proportion scheme to recover economic condition after post-disaster.

Only a few types of studies that evaluate the post-disaster budget for rehabilitation and reconstruction. Haque and Jahan, (2015) investigate expenses and failures, as well as investments in consumer spending and public/private investment to assist restore Bangladesh from the flood disaster. In addition, Haque and Jahan, (2015) found that induced loss has a large share for agriculture, manufacturing, construction, and housing services sectors. Consumer spending and public/private investment have a large impact on the manufacturing and construction sectors to recover from floods damages, while agriculture and housing services struggled to recuperate.

In this study, we evaluate the post-disaster budget for rehabilitation and reconstruction by identifying the induced output by this fiscal support. In Sect. 2, we describe the background on Mt. Merapi eruption and government recuperation budget 2011–2013. In Sect. 3, we explain the methodology and data in detail. In Sect. 4, we report the results and analysis, which containing outcomes for the natural disaster from the induced output of government restoration budget. We conclude and suggest the policy implications in Sect. 5.

2. Background

2.1 Mt. Merapi eruption 2010 and government special budget for rehabilitation and reconstruction

Mt. Merapi, 25–30 km north of the Yogyakarta Special Region's metropolitan area, and the surrounding area is home to approximately 1.6 million residents (Jousset et al., 2012). Figure 1 represents the geographic location of Mt. Merapi. It is located on latitude 7° 32'30" South and longitude 110° 26" 30" East and situated in a seduction zone between the Indo Australian and Eurasian plates. The volcanic activity in Sumatra, Java, Bali and Lesser Sunda guided by this disposition. It is known as the world's most active volcano with pyroclastic streams created by the collapse of the magma arches (Hariyono & Liliasari, 2018).

The early warning system at Mt. Merapi is the same as at all volcanoes in Indonesia and based on the analysis of instrumental and visual observations. It includes four forewarn steps:

Level I: It indicates the activity of the volcano is in the normal phase, with no indication of increasing business, even though poisonous gasses may threaten the area close to the carter.

Level II: set when visual and seismic data indicate that activity in level I is increasing.

Level III: This level defined when a trend of increasing unrest is continuing, and there is a concern that a dangerous eruption may occur.

Level IV: established when the initial eruption starts (i.e., ash/vapor erupts, which may lead to a more massive and more dangerous outbreak).

During the four levels of the explosion, the cautious in level IV was set before the first explosion and remained at IV through the end of the crisis. The vigilant level announced to the public through the National Agency of Disaster Management (BNPB) and the local governments (Jousset et al., 2012).

Furthermore, on October 25, 2010, the forecast proved accurate and timely as 35 h after the cautious issued, a colossal eruption began at 10:02 UTC on October 26, 2010, and ended at ~ 12:00 UTC. The volcanic eruption killed the renowned mystical guardian of Merapi volcano, Mbah Marijan and 34 others who refused to evacuate from the village of Kinahrejo, located 7 km from the summit. Moreover, Regional Disaster Management Agency (BNPB) statistical data mentioned that 367 people killed, 277 injured, and 410,388 people were displaced. The accurate forecasts by The Indonesian Center of Volcanology and Geological Hazard Mitigation (CVGHM) and immediate dismissions of many tens of thousands of people saved 10,000–20,000 lives (a conservative estimate based on BNPB reports of 2300 settlement ruined and multiplied by 4 to 8 people associated with each household) (Jousset et al., 2012).

Chronology of the eruption of Mt. Merapi based on the institute for investigation and development of mountainous technology, the CVGHM listed in Table 1.

Table 1
Chronology of the eruption of Mt. Merapi

Date of activity initiation	Activity detail
September 20, 2010	Activity status of Mt. Merapi increased from Level I (Normal) to Level II (Alert)
October 21, 2010	The status of Mt. Merapi activity increased from Level II (Alert) to Alert in Level III
October 25, 2010	Activity status of Mt. Merapi has increased from Alert in Level III to Level IV (Explosive phase). The safe area outside 10 km from Mt. Merapi Summit for inhabitants. Basic: Letter of the Head of the Center for Volcanology and Mitigation of Geological Disasters through the Head of BPPTK Yogyakarta Number 2044/45 / BGL.V / 2010 RR Action Plan for Mt. Merapi Eruption – 24 October 25, 2010. Subject: Increasing the Status of Mt. Merapi Activities from "Alert in Level III to" Level IV (Explosive phase) ".
October 26, 2010	The first eruption occurred at the distance of the hot clouds reaching 7.5 km from the peak of Mt. Merapi.
November 3, 2010	The activity of Mt. Merapi improved with the existence of constant warm clouds beginning at 11:11 WIB 15:00 WIB without stopping at a warm sliding range of 9 km from Mt. Merapi peak.
November 3, 2010	It was decided that the secure region beyond the 15 km radius from Mt. Merapi's summit.
November 4, 2010	A continuous eruption has occurred since November 3, 2010 with the gliding range of warm clouds reaching 14 km from the peak of Mt. Merapi with distribution to all the rivers that tipped on Mt. Merapi.
November 5, 2010	A secure zone is located outside a 20 km radius from the Merapi Summit. Preceded by a roar heard from the top of Mt. Merapi up to a range of 28 km.
November 14, 2010	Regional restrictions on safe areas have been decreased based on decreased activity and variety of warm cloud glides, 15 km and 10 km from Merapi Summit.
November 19, 2010	Decrease of the Mt. Merapi hazard zone, where the secure zone is located outside 10 km and 5 km from the Merapi summit.
December 3, 2010	Merapi Mountain activity status was reduced from Level IV (Explosive phase) to Alert in Level III, provided there was no activity within a radius of 2.5 km from the summit and the lahar hazard region was at a range of 300 m from the mouth of the river tipping at the peak of Mt. Merapi.

Based on the Law number 3/2007 concerning disaster management in chapter III about responsibility and authority, article 5 states that “The government and local government are responsible for the implementation of disaster.” Hence, post-disaster subscriptions need to be done immediately to restore the condition of the community and the environment caused by the disaster that has occurred. According to the regional disaster management agency of Yogyakarta Special Region (Regional Disaster Management Agency of Yogyakarta Special Region, 2011), the Mt. Merapi eruption has caused damage

and losses of 3,628 trillion Indonesia rupiah. In addition, the budget requires for rehabilitation and reconstruction estimated at 77,290 billion Indonesia rupiah - the rehabilitation and reconstruction (recovery) budget for this natural disaster allocated from central and local government.

3. Method And Data

3.1 Multiregional Input-Output (MRIO) Analysis

The MRIO analysis can be used to study the interrelationship between sub-national regions within a country and, initially, the theoretical basis of the interregional I-O model was developed by Isard, (1951) for the subnational level. Compared with recent developments of MRIOs at the international level, however, the number of up-to-date subnational MRIO tables and applications are much smaller (Többen & Kronenberg, 2015).

Additionally, Gallego and Lenzen, (2009) stated that if MRIO tables are to construct at the subnational level, non-survey methods are used to build a set of single-regional tables, which are afterward linked to each other via interregional trade estimated. A limited number of attempts have made at generating a sub-national MRIO system for Indonesia. Hulu and Hewings, (1993) created an interregional model consisting of 11 sectors and connecting five central regions of Indonesia: Sumatera, Java and Bali, Kalimantan, Sulawesi, and Eastern Indonesia. Moreover, Resosudarmo et al., (2009) extended a similar model to 35 sectors and embedded the resulting information into a Computable General Equilibrium (CGE) model (Resosudarmo, Yusuf, Hartono, & Nurdianto, 2009).

A similar input-output table can also construct on a regional level. The difference lies in the fact that at the local level, multiplier tends to be smaller in values as opposed to those at the country level. Sectors within the local economy may have to buy inputs from various industries in other regions, although still in the same country. Nevertheless, sectors within a province may also have to sell their products to different segments outside the zone (Resosudarmo, Hartono, & Nurdianto, 2009).

Furthermore, Resosudarmo et al., (2009a) mentioned that to know how these regions inter-connect through trade relations, it is necessary to construct a MRIO table (in annex *table A1*). The transactions are limited to those conducted between two regions of the same country; in other words, the country divided into two separate or some provinces. Each row in the MRIO table shows the number of goods and services sold to all sectors in both or some regions while each column indicates the number of products and services bought from all industries in the other provinces.

The multiregional input-output (MRIO) table is used to estimate the induced output impact of the special government budget (Central government and Yogyakarta Special Region government) which allocated for rehabilitation and reconstruction after the post-disaster of Mt. Merapi eruption 2010. And according to Miller and Blair, (2009), the induced output can be calculated using the formula:

$\Delta X = [I - A]^{-1}. \Delta F$ ……. (1)

Where $[I - A]^{-1}$ is the Leontief inverse matrix, ΔX is induced output, ΔF is an independent vector of final demand. This MRIO is treating the import section to put into the row below the intermediate input table, which means the input coefficient table does not include import trades.

3.2 Data

There are two kinds of data used to estimate the impact of the reconstruction and rehabilitation budget for Mt. Merapi eruption in 2010. First is the Interregional Input-Output Table of Indonesia 2005, which includes 30 provinces and 35 sectors, collected from Directorate of Regional Development of the National Development Planning Agency, (not published). Table 2 represents province name in Indonesia and Table 3 shows the sectors' classification of the MRIO table of Indonesia 2005.

Table 2
Province of Indonesia

Province number	Province's name in Indonesia	Province number	Province's name in Indonesia
1	Aceh	16	West Kalimantan
2	North Sumatera	17	Central Kalimantan
3	West Sumatera	18	South Kalimantan
4	Riau	19	East Kalimantan
5	Jambi	20	North Sulawesi
6	South Sumatera	21	Gorontalo
7	Bangka Belitung	22	Central Sulawesi
8	Bengkulu	23	South Sulawesi
9	Lampung	24	South East Sulawesi
10	Jakarta	25	Bali
11	West Java	26	West Nusa Tenggara
12	Banten	27	East Nusa Tenggara
13	Central Java	28	Maluku
14	Yogyakarta Special Region	29	North Maluku
15	East Java	30	Papua

Table 3
Sectors in the MRIO table of Indonesia 2005

Sectors' number	Sectors' name	Sectors' number	Sectors' name
1	Paddy/Rice	19	Cement Industry
2	Other Food Crops	20	Basic Metal Industry
3	Plantation Crops	21	Metal products Industry
4	Animal Husbandry	22	Electrical Equipment and Machinery Industry
5	Forestry	23	Transportation and Its Repair Industry
6	Fishery	24	Other industries
7	Oil, Gas and Geothermal Mining	25	Electricity, Gas and Clean Water
8	Coal, Metal Ore and Other Mining	26	Construction
9	Oil Refinery	27	Trade
10	Palm Oil Industry	28	Hotel and Restaurant
11	Marine Processing Industry	29	Land Transportation
12	Food and Beverage Industry	30	Water Transportation
13	Textile and Textile products Industry	31	Air Transportation
14	Footwear Industry	32	Communication
15	Wood, Rattan and Bamboo products Industry	33	Financial Institutions
16	Pulp and Paper Industry	34	General Government and Defense
17	Rubber and Rubber products Industry	35	Other Services
18	Petrochemical Industry		

Second is the recovery (reconstruction and rehabilitation) budget from both central and local (Yogyakarta Special Region) government 2011–2013. This budget is a particular budget that the government allocated to restore the condition after the eruption, where the data have been collecting from the regional disaster management agency of Yogyakarta special region (Regional Disaster Management Agency of Yogyakarta Special Region, 2011).

Table 4 depicts the recovery budget 2011–2013 from central and local government which allocated by sectors after it aggregated into sectors' name in MRIO table. We got amount of the recovery budget from

central and local governments respectively by items from 2011 to 2013. Each recovery budget is an accumulated amount over three years. Central government recovery budget is placed in the 3rd column in Table 4 and Yogyakarta government recovery budget is in the 4th column, and the final column shows the total one. According to the MRIO sector classification, 35 sectors, some items in the budget should be combined into certain sectors. The 1st column represents sector names in the MRIO, Indonesia (2005) and the 2nd column shows items included in corresponding sectors. Two rows at the bottom show total amount of each budget and the each share to total recovery budget, meaning that about 90% of recovery budget came from the central government. This total amount of the budget, about 773 thousands million rupiah, is more than 5 times of Yogyakarta's local government investment in 2005. In addition, we can see that a large amount of central government budget, roughly 266 thousand million rupiah, went to Forestry (Environment (National Park)) and much of Yogyakarta government budget, about 54 thousand million rupiah, was spent in Land Transportation.

Table 4
Reconstruction and rehabilitation/ recovery budget in 2011–2013

Sectors name in MRIO table 2005 (sector number)	Sectors name for government recovery budget	Central government recovery budget 2011–2013	Yogyakarta government recovery budget 2011–2013	Total recovery budget 2011–2013
Construction (26)	Housing	80,460.00	0.00	80,460.00
	Resident Infrastructure	2,736.78	0.00	2,736.78
	Settlement	1,500.00	0.00	1,500.00
	Recovery of housing and settlement	18,200.00	0.00	18,200.00
	Village land acquisition	27,185.42	0.00	27,185.42
Other Services (35)	Accompaniment	7,994.70	0.00	7,994.70
Land Transportation (29)	Road and Bridge	1,095.75	53,692.51	54,788.26
Electricity, Gas and Water (25)	Water and Sanitation	4,510.45	3,203.13	7,713.58
	Water resources infrastructure	36,590.00	1,650.00	38,240.00
	Energy	26.89	600.00	626.89
Communication (32)	Telecommunication	880.00	100.00	980.00
Land Transportation (29)	Rural Infrastructure	0.00	0.00	0.00
Paddy/Rice and Other Food Crops (1,2)	Agriculture	19,477.27	2,093.70	21,570.97
Fishery (6)	Fishery	3,366.33	8,653.67	12,020.00
Animal Husbandry (4)	Animal husbandry	40,262.50	700.00	40,962.50
Plantation (3)	Plantation	0.00	0.00	0.00

Note: in million rupiahs

Sectors name in MRIO table 2005 (sector number)	Sectors name for government recovery budget	Central government recovery budget 2011–2013	Yogyakarta government recovery budget 2011–2013	Total recovery budget 2011–2013
Financial Institution (33)	Small and Medium enterprises and cooperatives	1,518.63	1,590.46	3,109.09
Other Industries (24)	Industry	3,155.80	675.00	3,830.80
Trade (27)	Trade/Market	7,207.00	0.00	7,207.00
Hotel and Restaurant (28)	Tourism	814.38	662.00	1,476.38
Other Services (35)	Transmigration	56,000.00	50.60	56,050.60
	Health	15,879.07	705.32	16,584.39
	Education	65,931.94	1,663.32	67,595.26
	Religion	23,963.68	0.00	23,963.68
	Culture	598.09	590.04	1,188.13
	Social Institution	1,318.33	648.37	1,966.70
General Government and Defense (34)	Order and security (TNI/Polri)	50.00	745.00	795.00
Forestry (5)	Environment (National Park)	265,655.85	1,008.75	266,664.60
	Forestry	931.00	460.00	1,391.00
Financial Institution (33)	Finance and Banking	150.42	0.00	150.42
General Government and Defense (34)	Government	2,442.89	0.00	2,442.89
Other Services (35)	Disaster Risk Reduction	2,903.40	0.00	2,903.40
	Total	692,806.57	79,491.87	772,298.44
	Ratio of Budget	89.71%	10.29%	
Note: in million rupiahs				

Source: Regional Disaster Management Agency of Yogyakarta Special Region, (2011)

Table 5 shows allocation of the budget for all sectors from the recovery budget in Yogyakarta except Paddy/Rice and Other Food Crops. Since these two sectors are given as Agriculture at once in the recovery budget list, according to the proportion of Paddy/Rice and Other Food Crops in the MRIO table, we allocated the budget for each. As a result, we can see that four sectors such as Forestry, Construction, Land Transportation and Other Services are large sources of the recovery budget. Construction and Other Services become big amount after aggregating detailed items in the recovery budget table (Table 4) to correspond to the MRIO table. Due to the data limitation, we are assuming that industrial structure given by the MRIO, Indonesia 2005 has been unchanged during the period from 2011 to 2013. The last column in Table 5 is an independent (final demand) vector to be given for calculation of induced output in allover Indonesia that we want to get as direct and indirect impact of the recovery budget from Mt. Merapi eruption.

Table 5
Allocation recovery budget of post-Mt. Merapi eruption in 2010 according to proportion each sector

Sectors' Number	Sectors Name of MRIO Table 2005	Yogyakarta total output based on MRIO table 2005	Total aggregate of some sectors	The proportion of each sector (%)	Yogyakarta total recovery budget 2011–2013
1	Paddy/Rice	979,206.88	3,299,159.61	29.680%	6,402.37
2	Other Food Crops	2,319,952.73		70.320%	15,168.60
3	Plantation Crops				0.00
4	Animal Husbandry				40,962.50
5	**Forestry**				**268,055.60**
6	Fishery				12,020.00
7	Oil, Gas and Geothermal Mining				0.00
8	Coal, Metal Ore and Other Mining				0.00
9	Oil Refinery				0.00
10	Palm Oil Industry				0.00
11	Marine Processing Industry				0.00
12	Food and Beverage Industry				0.00
13	Textile and Textile products Industry				0.00
14	Footwear Industry				0.00
15	Wood, Rattan and Bamboo products Industry				0.00

Note: in million rupiahs

Sectors' Number	Sectors Name of MRIO Table 2005	Yogyakarta total output based on MRIO table 2005	Total aggregate of some sectors	The proportion of each sector (%)	Yogyakarta total recovery budget 2011–2013
16	Pulp and Paper Industry				0.00
17	Rubber and Rubber products Industry				0.00
18	Petrochemical Industry				0.00
19	Cement Industry				0.00
20	Basic Metal Industry				0.00
21	Metal products Industry				0.00
22	Electrical Equipment and Machinery Industry				0.00
23	Transportation and Its Repair Industry				0.00
24	Other industries				3,830.80
25	Electricity, Gas and Clean Water				46,580.47
26	**Construction**				**130,082.20**
27	Trade				7,207.00
28	Hotel and Restaurant				1,476.38
29	**Land Transportation**				**54,788.26**
30	Water Transportation				0.00
31	Air Transportation				0.00
32	Communication				980.00

Note: in million rupiahs

Sectors' Number	Sectors Name of MRIO Table 2005	Yogyakarta total output based on MRIO table 2005	Total aggregate of some sectors	The proportion of each sector (%)	Yogyakarta total recovery budget 2011–2013
33	Financial Institutions				3,259.51
34	General Government and Defense				3,237.89
35	**Other Services**				**178,246.86**
Note: in million rupiahs					

Source: author's calculation

4. Results And Discussion

Mt. Merapi located in the Yogyakarta special province, and it erupted in 2010 after the alert of level IV was an announcement before the first eruption. The eruption caused several damages and losses in many sectors. Due to this catastrophic, central and local government, in this term Yogyakarta special region government, attempt to recover the condition of the community and the environment caused by the disaster that has occurred by allocated particular budget to the natural disaster. This budget allocation by sector, as an independence vector of final demand is adjusted to the sectors in the MRIO Table of Indonesia 2005, as mentioned in Table 5.

Calculating the induced output by the Eq. (1), we got Table 6 and Table 7. In Table 6, we show top 20 of the induced output over Indonesia by the recovery budget for the Mount Merapi eruption. In Table 7, we show the induced output in Yogyakarta province by the recovery budget for the Mt. Merapi eruption. In this table, the total impact by the recovery budget is 1,298,701 million Indonesian rupiahs. It increases the total output of the Yogyakarta Special Region province approximately 2.33% after the disaster occurred. The highest induced appears for the forestry sector (21.66%), followed by other services and construction sectors, which are 17.75% and 10.41%, respectively. These three sectors' large results are reasonable because the allocation of budget was relatively large as Table 5 shows. For example, the substantial budget for these sectors is required for reforestation, repair facilities, and infrastructure that damaged around the Mt. Merapi area due to its lethality.

According to the Regional Disaster Management Agency of Yogyakarta Special Region (2011), forest restoration or reforestation is more centered on forest regeneration in the National Park Area of Mount Merapi, which has been impacted by vegetation damage events, animal migration (long-tailed monkeys, birds, tigers, pig forests, etc.) in the National Park Area, and ecosystem harm. This is because in balancing the wider regional ecosystem, the Mount Merapi National Park Area plays a significant role. This region of approximately 6,000 hectares is a protected forest area where approximately 4,000

hectares is a vegetated area (approximately 1,128 hectares) destroyed by warm clouds, covered by volcanic ash, and burned during Mt. Merapi eruption.

Table 6
Induced output by recovery budget of post-Mt. Merapi eruption in 2010 (Top 20) in Indonesia

Province name	Sectors	Sectors name	Total output MRIO 2005	Induce output 2011–2013	Share to total induced output
Yogyakarta	5	Forestry	364,689	281,356	21.66%
Yogyakarta	35	Other Services	6,881,704	230,583	17.75%
Yogyakarta	26	Construction	5,823,860	135,258	10.41%
Yogyakarta	29	Land Transportation	3,360,078	71,133	5.48%
Yogyakarta	25	Electricity, Gas and Clean Water	447,187	56,795	4.37%
Yogyakarta	4	Animal Husbandry	1,177,680	48,613	3.74%
Yogyakarta	27	Trade	3,146,374	46,570	3.59%
Yogyakarta	28	Hotel and Restaurant	5,005,519	42,866	3.30%
Yogyakarta	12	Food and Beverage Industry	4,367,263	31,317	2.41%
Yogyakarta	2	Other Food Crops	2,319,953	23,797	1.83%
Yogyakarta	21	Metal products Industry	47,367,086	21,765	1.68%
Yogyakarta	33	Financial Institutions	795,337	20,342	1.57%
Yogyakarta	24	Other industries	1,884,047	17,047	1.31%
Yogyakarta	15	Wood, Rattan and Bamboo products Industry	1,143,341	15,636	1.20%
Yogyakarta	1	Paddy/Rice	979,207	14,317	1.10%
Yogyakarta	6	Fishery	102,556	12,191	0.94%
Central Java	9	Oil Refinery	67,491,080	10,966	0.84%
Jakarta	23	Transportation and Its Repair Industry	72,172,585	10,555	0.81%
Jakarta	33	Financial Institutions	119,600,201	9,034	0.70%
East Java	3	Plantation Crops	15,594,212	7,933	0.61%

Note

in million rupiahs

Table 7
Induced output by recovery budget of post-Mt. Merapi eruption in 2010 (Top 20) in Yogyakarta provinces

Provinces	Sectors	Sectors name	Total output MRIO 2005	Induce output 2011–2013	Share to total induced output
Yogyakarta	5	Forestry	364,689	281,356	21.66%
Yogyakarta	35	Other Services	6,881,704	230,583	17.75%
Yogyakarta	26	Construction	5,823,860	135,258	10.41%
Yogyakarta	29	Land Transportation	3,360,078	71,133	5.48%
Yogyakarta	25	Electricity, Gas and Clean Water	447,187	56,795	4.37%
Yogyakarta	4	Animal Husbandry	1,177,680	48,613	3.74%
Yogyakarta	27	Trade	3,146,374	46,570	3.59%
Yogyakarta	28	Hotel and Restaurant	5,005,519	42,866	3.30%
Yogyakarta	12	Food and Beverage Industry	4,367,263	31,317	2.41%
Yogyakarta	2	Other Food Crops	2,319,953	23,797	1.83%
Yogyakarta	33	Financial Institutions	795,337	20,342	1.57%
Yogyakarta	24	Other industries	1,884,047	17,047	1.31%
Yogyakarta	15	Wood, Rattan and Bamboo products Industry	1,143,341	15,636	1.20%
Yogyakarta	1	Paddy/Rice	979,207	14,317	1.10%
Yogyakarta	6	Fishery	102,556	12,191	0.94%
Yogyakarta	8	Coal, Metal Ore and Other Mining	263,887	5,571	0.43%
Yogyakarta	32	Communication	970,166	5,475	0.42%
Yogyakarta	16	Pulp and Paper Industry	352,032	5,306	0.41%
Yogyakarta	34	General Government and Defense	3,582,312	3,239	0.25%
Yogyakarta	13	Textile and Textile products Industry	1,551,075	2,492	0.19%

Source: author’s calculation

In addition, land transaction, electricity, gas and clean water, animal husbandry, trade, hotel and restaurant are induced with relatively large scale, where the share to total induced output is about 3–5%. Sectors like land transaction, and electricity, gas and clean water are infrastructure related sectors, which are necessarily required for the recovery. Interestingly, among many agricultural goods, animal husbandry is frequently traded goods for farmers in Yogyakarta. Trade, hotel and restaurant are also seen as necessary activity for their daily life.

This induced output from a particular government budget for Mt. Merapi eruption in 2010 has a prominent contribution not only for Yogyakarta special region province but also for other regions nearby, for instance, Central Java, West Java, Jakarta, and East Java. And has contribution in many sectors i.e. metal products industry sector in West Java, transportation and its repair industry sector in Jakarta, oil refinery sector in Central Java, and also plantation crop sector in East Java equal to 1.68%, 1.51%, 0.84%, and 0.61% respectively.

Table 8 represents repercussion effects to other provinces as induced outputs by the recovery budget in Yogyakarta. Each share of the result to total induced outputs is relatively small, but this result shows interdependency of Yogyakarta to other provinces through their intermediate and final demand, in particular industries. For example, West Java and Central Java are supplying metal products, petrochemical products and refinery oil to Yogyakarta as well as Jakarta provides transportation and its repairing, financial services and trade services. Interestingly, not only neighboring areas of Yogyakarta but also some remote areas are connecting through the trade (Fig. 2). Papua and South Sumatera are geographically far from Yogyakarta, but they are playing important role of supply base of coal and rubber respectively. East Java also provides plantation crops and cement products to Yogyakarta.

Table 8
The induced output impact by recovery budget of post-Mt. Merapi eruption in 2010 to the provinces excluding Yogyakarta

Provinces	Sectors' number	Sectors name on MRIO table 2005	The induced output of recovery budget 2011–2013	Share to the induced output
West Java	21	Metal products Industry	21,765	1.68%
Central Java	9	Oil Refinery	10,966	0.84%
Jakarta	23	Transportation and Its Repair Industry	10,555	0.81%
Jakarta	33	Financial Institutions	9,034	0.70%
East Java	3	Plantation Crops	7,933	0.61%
Papua	8	Coal, Metal Ore and Other Mining	6,689	0.52%
South Sumatera	17	Rubber and Rubber products Industry	6,613	0.51%
East Java	19	Cement Industry	5,668	0.44%
West Java	18	Petrochemical Industry	5,539	0.43%
Jakarta	27	Trade	4,773	0.37%
Total Induce Output of Recovery Budget 2011–2013			1,298,701	
Source: author's calculation				

It implies that Yogyakarta Special Region still has interconnection in various sectors of regional economies despite affected by natural hazards and all Indonesian provinces in many sectors provide support and assistance to recuperate Yogyakarta from the catastrophic volcanic eruption in 2010. According to Table 8, it seems that provinces which have relatively strong trade connection with Yogyakarta provide basic needs like energy, infrastructure and fundamental services like transportation and trade.

5. Conclusion And Policy Implications

Because of location in most effective natural calamity hotspots, several types of a disaster such as earthquakes, tsunamis, volcanic eruptions, floods, drought, landslides, and forest fires are frequently occurring in Indonesia. It made the government, both central and local government allocate budget to recuperate it. The rehabilitation and reconstruction (recovery) budget are used to rejuvenate the condition

after a disaster happens. This study estimates the induced output of a limited government budget for recovering the natural hazard, in this case, the Mt. Merapi eruption in 2010 by using multiregional input-output (MRIO) table, Indonesia (2005).

Our main findings are, firstly, to recover Yogyakarta region from the disaster, Indonesia's central and local government put the recovery budget of totally about 773 thousand million rupiah over 2011 to 2013. This magnitude was more than 5 times comparing with Yogyakarta's local government investment in 2005 MRIO, Indonesia. Secondly, Forestry, Other services, and Construction sectors have received a significant share of induced effects (totally around 50% to the total effects) from the particular government budget to recover from the calamity because allocation of recovery budget was mainly concentrated into these sectors. Since forestry is a valuable natural resource in Yogyakarta and construction is necessary cost to recover from the disaster, this result would be reasonable. Finally, the induced effect of this budget also has the effect to other provinces, which has relatively strong connection with Yogyakarta Special Region province through their supply chains. For instance, nearby Central Java province, which supply refinery oil, and remote Papua province, which supply of coal and rubber, benefited from this budget allocation.

Our findings guide several key policy implications regarding the impact of the induced output of fiscal support in developing countries. The induced effect of the recovery budget is essentially beneficial for the damaged region. In addition, the supply chain network also induced potential benefit to nearby trading regions. However, this policy implications need to be evaluated scientifically by taking the actual case study from other developing countries.

Our calculation in this research is based on the MRIO, Indonesia 2005 as mentioned above, but the recovery budget for Mt. Merapi eruption in 2010 was accumulated amount from 2011 to 2013. The economic structure change during the study period can create some inaccuracy in our results. However, the significance of this research is to show the magnitude of interdependency of disastrous region with other areas through their transaction. As we told above, an important policy implication is that not only nearby region of the ground-zero area but also some remote areas linking with there would receive unintentional repercussion effects from the recovery from the disaster, which might lead other regions' economic development. Our results are the typical example of the case and future study can focus on the impact of the induced output by fiscal support in developing countries.

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Figures

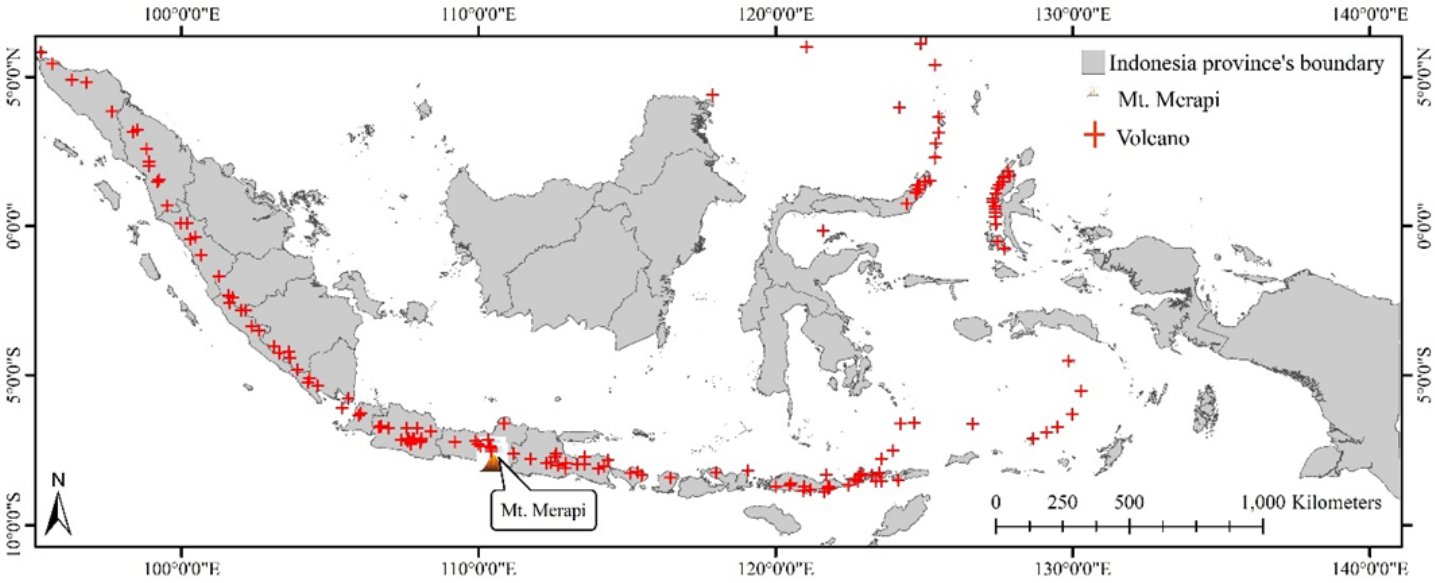

Figure 1

Study area in Indonesia

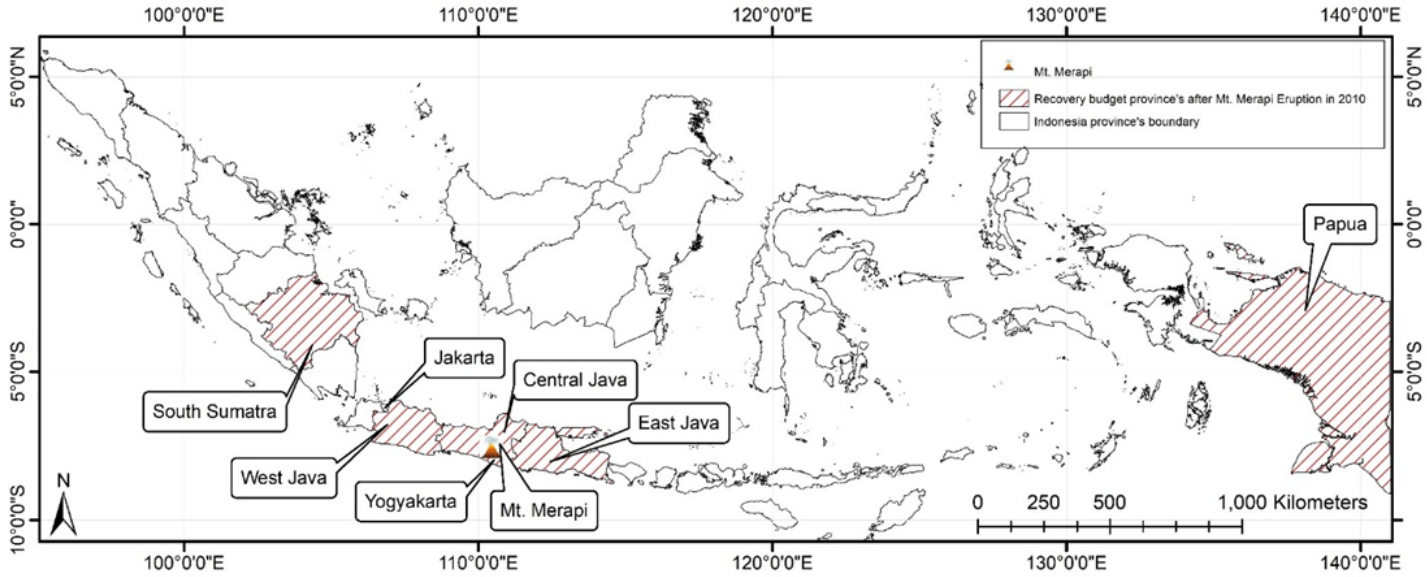

Figure 2

Location of provinces with significant impact due to Mt. Merapi eruption in 2010

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