JURNAL_CSC 2019_2

by Maryono Maryono

IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

Basic Framework of Regional Model for Disaster Waste Estimation and Distribution by Using Spatial Approach in Central Java-Indonesia

To cite this article: M Maryono *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **396** 012019

Basic Framework of Regional Model for Disaster Waste Estimation and Distribution by Using Spatial Approach in Central Java-Indonesia

M Maryono[1,2], K Seruyaningtyas[2], A D Roynaldi[2], Sudarno[3], Hadiyanto[2,4]

[1]Department of Urban and Regional Planning, Faculty of Engineering, Diponegoro University-Indonesia
[2]Center for Green Infrastructure Resilience and Development (C-Greinde), Master Program of Environmental Science, School of Postgraduate, Diponegoro University-Indonesia
[3]Department of Environmental Engineering, Faculty of Engineering, Diponegoro University-Indonesia
[4]Department of Chemical Engineering, Faculty of Engineering, Diponegoro University-Indonesia

E-mail: m.maryono@undip.ac.id

Abstract. Disaster are becoming more frequent around the world and more intense in urban areas. Central Java is the province with the largest number of disasters in Indonesia. Disaster create amount of disaster waste and sometime very huge, many times comparing to daily municipal waste generation. Government and local citizen sometimes are unable to handling disaster waste. Since effective implementation of disaster waste management (DWM) will lead quick and better recovery of living and avoid more environmental risk, high level regional government such as provincial should help. To make effective support, it is important that provincial government develop a model to monitor disaster waste generation in each regency and cities. This study aims to develop basic framework of regional model for disaster waste estimation and distribution in provincial level. This study used Central Java Province as a case study. To estimate disaster waste in Central Java, this study developed an index system as a basic model. It is about basic comparison of disaster waste generation in all central java regencies or cities. Disaster waste is associated with total disaster events. This study utilized GIS tools to express model and system. This study developed of regional model disaster waste estimation in Central Java, divided by 3 sub decades. Study result shown that in first decade 1990-1999 the highest index of disaster waste estimation is Brebes Regency. Second decade 2000-2009 the highest index of disaster waste estimation is Semarang Regency and the third decade 2010-2018 the highest index of disaster waste estimation in Cilacap Regency.

Keywords: Disaster Waste Estimation, Infrastructure Resilience, Index Based Model, GIS, Central Java.

1. Introduction

Indonesia is one of prone country in the world. For year 2018 there is Indonesia Disaster Management Agency known as BNPB recorded 3398 disaster events in Indonesia [1]. Disaster can create a lot of disaster waste, sometimes, it is a huge and many times compare with annual municipal waste generation. According to the Indonesian experience from Tsunami Waste Recovery Waste Management Project, at least 8 years total time is needed to recover all waste management Infrastructure [2]. Disaster waste management (DWM) should be prepared properly. Effective and efficient of disaster waste management creates many advantages not only for disaster recovery but also for economic recovery by exploring any challenges in the recycling proses of disaster waste management [3]. Disaster waste material can be recycled and reused, especially for housing recovery.

When huge disaster waste generated, local government usually unable to handling. They need support others and intervention from high level of authority usually needed. They need support from other government both from Provincial and National government. To prepare it, Provincial and National government need a basic information of disaster waste generation. It is need to estimate the requirement of infrastructure and other resources. Development model for disaster waste estimation is very important for Indonesia region. Availability of disaster waste information in a regional level such as provincial in Indonesia, lead an effective effort to achieve disaster resilience. Basic model of regional disaster waste estimation is not only for DWM but also for preparing effective approaches, avoid environmental risk, increasing safety and health. Effective monitoring of disaster waste generation also leads more faster in respond, recovery and development [4,5]. This basic model is developed not only for developed disaster resilience, but also for achieving of the 17 Sustainable Development Goals (SDGs) especially goal number 11, to make cities inclusive, safe, resilient and sustainable [6]. This goal states that, by 2020, countries and all citizen should make any effort to adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation, and adaptation to climate change, along with resilience to disasters by 2030 [6]. Moreover, since the disaster waste generation is correlated with physical infrastructure resilience, this research is also tried to give basic information of physical rural urban infrastructure resilience against the disasters [6].

Disaster waste estimation model can be developed by manual system, integrated system. Moreover, disaster waste estimation model can be developed by using on line system or by using internet line and automatic system. Internet of thing for waste management in peace time, has been explored and become challenging issues in recent year [7–9]. Some factor will influence to the system such as availability of technology, availability of human resource and organization, and availability of budget [7–9]. However, the model can be developed step by step according to the condition and the availability of resources.

2. Data and methods

2.1. Study area

Indonesia is a disaster-prone country that consist of 34 provinces. To perform the basic model of disaster waste estimation model, this study selected Central Java Province. It is a part of a case study method to describes the issues of disaster waste estimation model in Indonesia [10,11]. This province is very unique, many disasters attacked to the region such as earthquake, storm and floods, landslides, and volcanic eruptions. Central Java is one of the prime locations of Indonesia which consist of 29 local government (regency) and 6 city government. Indonesia Disaster Management Agency known as BNPB calculated that Central Java is the province with the most disasters events in Indonesia with 3389 disaster event in 2018 [1].

2.2. Method

Spatial approach within GIS utilization has been growth quickly in recent years. It is not only for giving fast respond, but also for improving accuracy [12]. However, in disaster waste management, there is no information issued, and research toward disaster waste information is needed [13]. DWM guidelines issued by Japan ministry of environment [14], and issued by united nation for environmental program [15] did not give any suggestion and method to developed the information system. This study developed basic model to estimate disaster waste by using index model. The Index Model is described value of one region compare to the total value in region. Moreover, this study is descriptive quantitative of secondary data to performing the index model. The data of disaster events collected from The National Disaster Management Agency (BNPB) Indonesia [1]. To build the basic model, the estimation of disaster waste generation index is analysis by utilized the number of disaster event in each regency

IOP Conf. Series: Earth and Environmental Science **396** (2019) 012019 doi:10.1088/1755-1315/396/1/012019

and city compared to the number of totals of disaster event in Central Java Province. The basic index for regional disaster waste monitoring calculated by the formula as follow:

$$\frac{\Sigma i}{\Sigma ni}$$

with,
i = the number of disaster events in a regency or city
ni = the number of disasters in Central Java

Automatic system to calculated disaster event in central java, developed by utilized data on line system from the DIBI provide by BNPB [1]. Moreover, automatic system for understanding spatial distribution of disaster waste estimation, this study utilized GIS tools. GIS is a spatial approach for making any spatial information. GIS in this study used to comparing degree of disaster waste estimation and distribution of disaster waste generation in each region in Central Java compare to other.

3. Result and discussion

Model to estimate disaster waste generation is one of the significant stages for DWM [7]. Moreover, according to the estimation model, any infrastructure requirement to handling volume and characteristic to avoid environmental disturbance can be developed [3,7]. Disaster waste are vary depending of the characteristic of the region, natural and man-made infrastructure at which disaster happen. Wastes may consist of destroyed buildings and the objects they held inside, destroyed pavements or other infrastructure, wood, sands, and other natural derivatives and so on. Not only are wastes directly generated from disasters, activities in recovery and reconstruction in the post-disaster phase also generate waste [3,7].

Disaster waste generation can be estimated by using disaster event in Central Java. This study utilized data from the DIBI recorded by Indonesian Disaster Management Agency known as BNPB [1]. As shown in table 1. in the decade 1990-1999 BNPB administered 29 disaster events, for year 2000-2010 there are 1351 disaster event in Central Java Province, and for year 2010-2018 BNPB recorded 4706 disaster events. Brebes Regency, Semarang Regency and Cilacap Regency is the highest level affected by the disaster.

Tabel 1. Regional Disaster Event in Central Java Province 1990-1999, 2000-2009, 2010-2018

No	Regency/City	Disaster Event 1990-1999	Regency/City	Disaster Event 2000-2009	Regency/City	Disaster Event 2010-2018
1	Brebes	3	Semarang	108	Cilacap	591
2	Kendal	3	Wonosobo	104	Wonogiri	351
3	Semarang City	3	Cilacap	95	Temanggung	271
4	Cilacap	2	Banyumas	94	Magelang	264
5	Wonosobo	2	Wonogiri	65	Banyumas	262
6	Demak	2	Rembang	65	Semarang City	225
7	Semarang	2	Brebes	57	Banjarnegara	165
8	Tegal City	2	Kebumen	51	Purbalingga	163
9	Banyumas	1	Karanganyar	51	Kebumen	158
10	Purbalingga	1	Klaten	49	Boyolali	148
11	Kebumen	1	Boyolali	44	Wonosobo	147
12	Purworejo	1	Sukoharjo	42	Karanganyar	146
13	Sukoharjo	1	Pati	39	Semarang	144
14	Wonogiri	1	Sragen	35	Pati	141
15	Sragen	1	Grobogan	35	Pemalang	141
16	Grobogan	1	Tegal	35	Pekalongan	140
17	Pati	1	Pekalongan	33	Purworejo	119

IOP Conf. Series: Earth and Environmental Science **396** (2019) 012019 doi:10.1088/1755-1315/396/1/012019

No	Regency/City	Disaster Event 1990-1999	Regency/City	Disaster Event 2000-2009	Regency/City	Disaster Event 2010-2018
18	Kudus	1	Semarang City	33	Kendal	118
19	Banjarnegara	0	Jepara	31	Sragen	110
20	Magelang	0	Magelang	29	Jepara	101
21	Boyolali	0	Blora	27	Brebes	95
22	Klaten	0	Kudus	26	Klaten	93
23	Karanganyar	0	Banjarnegara	25	Grobogan	88
24	Blora	0	Demak	25	Tegal	83
25	Rembang	0	Kendal	25	Kudus	78
26	Jepara	0	Pemalang	24	Blora	76
27	Temanggung	0	Purworejo	23	Demak	76
28	Batang	0	Temanggung	21	Sukoharjo	60
29	Pekalongan	0	Purbalingga	18	Rembang	44
30	Pemalang	0	Batang	16	Surakarta City	34
31	Tegal	0	Surakarta City	14	Batang	32
32	Magelang	0	Pekalongan City	8	Magelang City	13
33	Surakarta city	0	Tegal City	3	Tegal City	13
34	Salatiga City	0	Magelang City	1	Pekalongan City	11
35	Pekalongan City	0	Salatiga City		Salatiga City	5
	Total	29		1351		4706

Source of table [1]

The number of disasters is identical to the number of disaster waste generation. Disaster waste generation is correlated with physical infrastructure resilience. Even though the disaster waste is very dependent on the type and characteristics of the disaster, the number of disasters can represent amount of the disaster waste.

By using disaster event from National Disaster Management Agency [1], this study examined and calculated estimation of disaster waste generation index in Central Java. Table 2 describe the result of the calculation and examination. Based on the table 1, the number of disasters occurring in Central Java is increasing. Disaster waste generation index shows the number of disasters in each city that occurred in 1990-1999, 2000-2009, 2010-2018. The range of the index disaster are 0,000-0,103 in year 1990-1999; 0,000-0,077 in year 2000-2009; and 0,002-0,126 in year 2010-2018.

Tabel 2. Regional Disaster Waste Generation Index in Central Java Province

Regency and Cities of Central Java	Regional Disaster Waste Generation Index Based on calculation and analysis of disaster event per region and cities		
	1990-1999	2000-2009	2010-2018
Cilacap	0,069	0,070	0,126
Banyumas	0,034	0,070	0,056
Purbalingga	0,034	0,013	0,035
Banjarnegara	0,000	0,019	0,035
Kebumen	0,034	0,038	0,034
Purworejo	0,034	0,017	0,025
Wonosobo	0,069	0,077	0,031

Magelang	0,000	0,021	0,056
Boyolali	0,000	0,033	0,031
Klaten	0,000	0,036	0,020
Sukoharjo	0,034	0,031	0,013
Wonogiri	0,034	0,048	0,075
Karanganyar	0,000	0,038	0,031
Sragen	0,034	0,026	0,023
Grobogan	0,034	0,026	0,019
Blora	0,000	0,020	0,016
Rembang	0,000	0,048	0,009
Pati	0,034	0,029	0,030
Kudus	0,034	0,019	0,017
Jepara	0,000	0,023	0,021
Demak	0,069	0,019	0,016
Semarang	0,069	0,080	0,031
Temanggung	0,000	0,016	0,058
Kendal	0,103	0,019	0,025
Batang	0,000	0,012	0,007
Pekalongan	0,000	0,024	0,030
Pemalang	0,000	0,018	0,030
Tegal	0,000	0,026	0,018
Brebes	0,103	0,042	0,020
Magelang City	0,000	0,001	0,003
Surakarta City	0,000	0,010	0,007
Salatiga City	0,000	0,000	0,001
Semarang City	0,103	0,024	0,048
Pekalongan City	0,000	0,006	0,002
Tegal City	0,069	0,002	0,003

Source: Calculation and analysis.

3.1 Basic Framework of Regional Model for Disaster Waste Estimation and Distribution in by using Spatial Approach in Central Java 1990-1999

To perform the basic regional model of disaster waste estimation and distribution in year 1990-1999, the study utilized the disaster waste estimation index for year 1990-1999 as shown in table 2 and GIS tools. The result of the basic regional model in year 1990-1999 shown in figure 1.

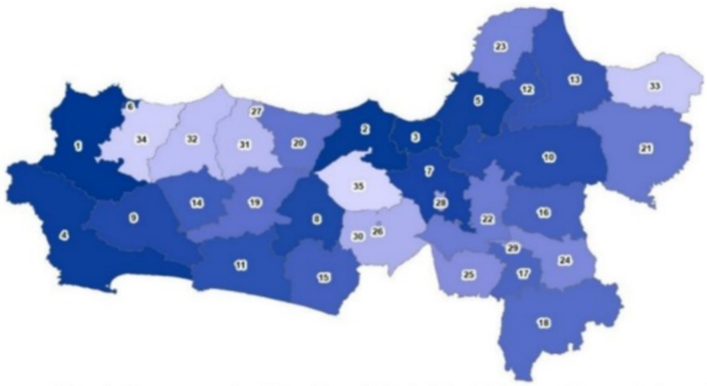

Figure 1. Basic Framework of Regional Model for Disaster Waste Estimation and Distribution by Using Spatial Approach in Central Java 1990-1999

Based from the figure 1, the gradation color on the map means there is a different disaster waste in Central Java. The regency or cities with bold colors mean the region is more high disaster waste generated compared to the regency of cities with bright colors. Refers to the regional model of disaster waste estimation in 1990-1999, the region in Central Java region with highest degree level of disaster waste estimation is Brebes regency, while the region with lowest degree level of disaster waste is Temanggung regency.

Cutter et all in year 2008 used spatial approach when they build a basis model of resilience indicator for baseline indicator [16,17] to analysis baseline condition and it improvement. Moreover, Modica & Reggiani in year 2015 use spatial approach to analysis economic resilience [18]. Starting from those previous researches this study is using spatial approach as a basis framework for analyzing disaster waste estimation and distribution since disaster waste estimation is a basis framework to build spatial resilience.

3.2 Basic Framework of Regional Model for Disaster Waste Estimation and Distribution in Central Java 2000-2009

After conducted the first model, the study continued to build the second model of basic regional disaster waste estimation for year 2000-2009. There several aims such as: (1) to understanding the consistency of the approach, (2) to examine the continuity of the model, and then (3) to assess the differences and or changing of each region as of disaster waste generated in each region. The result of Regional Model of Disaster Waste Estimation for 2000-2009 is described in figure 2.

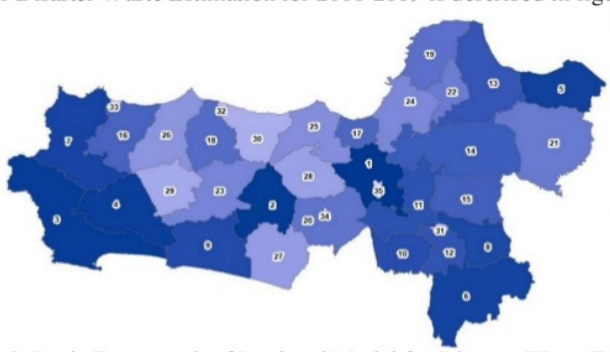

Figure 2. Basic Framework of Regional Model for Disaster Waste Estimation and Distribution by Using Spatial Approach in Central Java 2000-2009

Based from the figure 2, the model is consistent at which it is a comparison of one region to other region. The model also can be continued, at which all data in the table 1 can be execute and running by utilizing GIS tools. The model examined the differences and the changing between region in central Java province. as shown in figure 2, regency and cities in central Java is change. There is difference index and basic spatial model compare to the model previously as describe in figure1. As shown in figure 2. basic framework for regional model of disaster waste estimation and distribution in 2000-2009, the region in Central Java region with highest degree level of disaster waste estimation is changing become Semarang regency, while the region with lowest degree level of disaster waste is changing become Salatiga city.

3.3 Basic Framework of Regional Model for Disaster Waste Estimation and Distribution in by using Spatial Approach in Central Java 2010-2018

By using the same method, analysis then continued to perform the third model for analysis regional disaster waste estimation and distribution for year 2010-2018 in Central Java Province. Figure 3 describe basic framework for regional model of disaster waste estimation and distribution for year 2010-2018. Refers to the model, region with highest degree level at which bold color is still Cilacap regency while region with lowest disaster waste estimation index is same as previous regional model in figure 2 namely Salatiga city. According to the figure 3, all of region is changing, however Cilacap regency is most dominant compare to the other regions. With index as shown in table 1 estimated 0,126, it is the highest index during time period of study for 38 year from 1990- 2018.

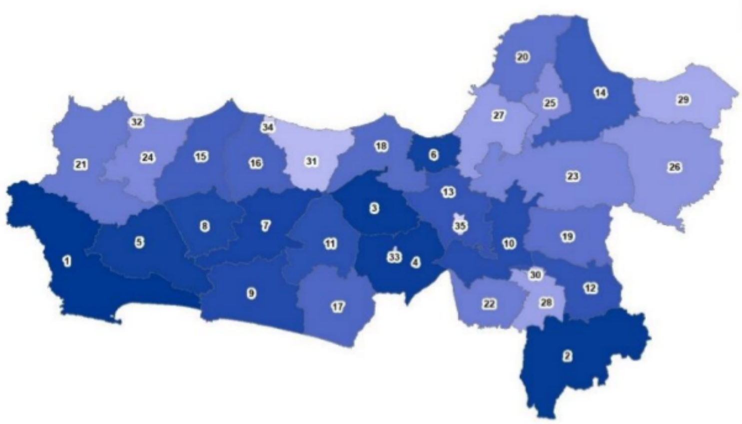

Figure 3. Basic Framework of Regional Model for Disaster Waste Estimation and Distribution by Using Spatial Approach in Central Java 2010-2018

Refers to the figure 3, there is no region that not changing comparing to the previous model in figure 2. This mean that the model is consistent and valid to describe the estimation of disaster waste generation in one region compared to another region in Central Java.

3.4 Pattern of Regional Disaster Waste Estimation 1990-1999,2000-2009, 2010-2018

Pattern of regional disaster waste estimation and distribution for year 1990-1999, 2000-2009, 2010-2018 is describe in figure 4. As shown in the figure the basic framework of regional model for disaster waste estimation and distribution in Central Java at which divide by three period is not have a big change. The figure shown that the pattern is similar. Degree of change for regional model of disaster waste estimation and distribution for three decades namely 1990-1999, 2000-2009, and 2010-2018 is very slow. There are four pattern of disaster waste generation characteristic in Central Java Region such as;(1) Cilacap Regency is one of the biggest and highest level of region at which there is high probability of high disaster waste generation

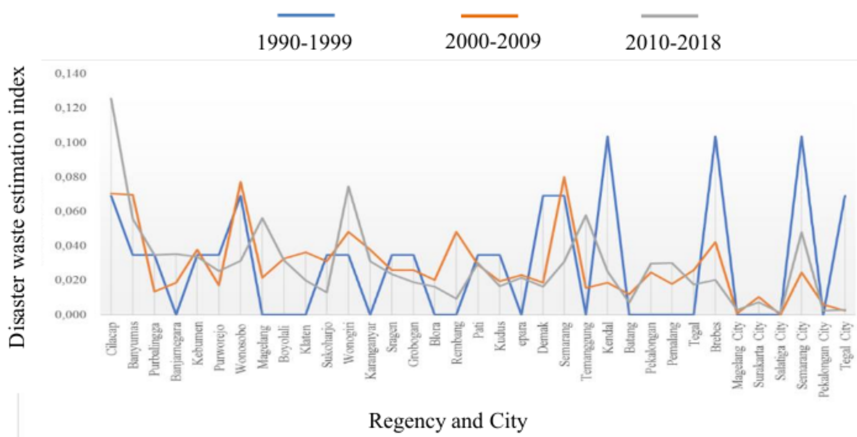

Figure 4. Degree Changing for Regional Model of Disaster Waste Estimation in three decade

4. Conclusion

Disaster waste estimation and distribution in a regional scale is part of planning to understanding spatial and geographical effort to build natural disaster resilience since to handling disaster waste properly, planning for infrastructure, planning for resources and planning for budgeting is very importance [7,19]. To analysis disaster waste generation and distribution can be calculated by using the disaster event at which recorded, even though disaster waste generation is specific depend on type of disaster, but this approach can be utilized to build a basic model and framework. This study developed a basic framework for regional model of disaster waste estimation and distribution in central Java. This model analysis disaster waste estimation and distribution model base on the disaster event for year 1990-1999, for year 2000-2009, and for year 2010-2018. This model shown that in central Java Brebes Regency is the biggest and highest index of disaster waste estimation and distribution for decade 1990-1999. Semarang Regency is the highest disaster waste estimation and distribution for decade 2000-2009 while Cilacap is the highest for year 2010-2018.

5. Acknowledgement

This article was presented at the 2nd International Conference on Smart City INNOVATION (ICSCI) 2019, jointly held by Universitas Indonesia and Universitas Diponegoro. ICSCI conferences have been supported by the United States Agency for International Development (USAID) through the Sustainable Higher Education Research Alliance (SHERA) Project for Universitas Indonesia's Scientific Modelling, Application, Research, and Training for City-centered Innovation and Technology (SMART CITY) Center for Collaborative Research, administered through Grant #AID-4=97-A-1600004, Sub Grant #IIE-00000078-UI-1. This research is funded by the Directorate General of Research and Development, Ministry of Research, Technology and Higher Education through Institute for Research and Community Services Diponegoro University for year 2019 with contract number 257-66/UN7.P4.3/PP/2019.

IOP Conf. Series: Earth and Environmental Science **396** (2019) 012019 doi:10.1088/1755-1315/396/1/012019

6. References

[1] Indonesia Disaster Management Agency 2019 Data Informasi Bencana Indonesia

[2] UNDP Indonesia 2012 Tsunami Recovery Waste Management Project (TRWMP)

[3] Asari M, Sakai S, Yoshioka T, Tojo Y, Tasaki T, Takigami H and Watanabe K 2013 Strategy for separation and treatment of disaster waste: a manual for earthquake and tsunami disaster waste management in Japan *J. Mater. Cycles Waste Manag.* **15** 290–9

[4] Noran O and Bernus P 2011 Effective Disaster Management: An Interoperability Perspective *On the Move to Meaningful Internet Systems: {OTM} 2011 Workshops* (Springer Berlin Heidelberg) pp 112–21

[5] Gowan M E 2011 Self-Management of Disaster Risk and Uncertainty: The Role of Preventive Health in Building Disaster Resilience

[6] SDG Indonesia 2017 Sustainable Development Goals

[7] Brown C O 2012 Disaster Waste Management: a systems approach

[8] Shyam G K, Manvi S S and Bharti P 2017 Smart waste management using Internet-of-Things ({IoT}) *2017 2nd International Conference on Computing and Communications Technologies ({ICCCT})* (IEEE)

[9] Tao C and Xiang L 2010 Municipal Solid Waste Recycle Management Information Platform Based on Internet of Things Technology *2010 International Conference on Multimedia Information Networking and Security* (IEEE)

[10] Zainal Z 2007 Case study as a research method *J. Kemanus.* **5**

[11] Smith W and Dowell J 2000 A case study of co-ordinative decision-making in disaster management *Ergonomics* **43** 1153–66

[12] Li W, Song M, Zhou B, Cao K and Gao S 2015 Performance improvement techniques for geospatial web services in a cyberinfrastructure environment - A case study with a disaster management portal *Comput. Environ. Urban Syst.* **54** 314–25

[13] Milke M 2011 Disaster waste management research needs *Waste Manag.* **31** 1

[14] Ministry of the Environment Goverment of Japan 2018 *Disaster Waste Management Guideline For Asia Pacific*

[15] United Nations Office For The Coordination of Humanitarian Affairs Environmental Emergences Section 2011 *Disaster Waste Management Guideline United Nation*

[16] Etinay N, Egbu C and Murray V 2018 Building Urban Resilience for Disaster Risk Management and Disaster Risk Reduction *Procedia Eng.* **212** 575–82

[17] Cutter S L, Burton C G and Emrich C T 2010 Disaster Resilience Indicators for Benchmarking Baseline Conditions *J. Homel. Secur. Emerg. Manag.* **7**

[18] Modica M and Reggiani A 2014 Spatial Economic Resilience: Overview and Perspectives *Networks Spat. Econ.* **15** 211–33

[19] Zhou H, Wang J, Wan J and Jia H 2009 Resilience to natural hazards: a geographic perspective *Nat. Hazards* **53** 21–41

JURNAL_CSC 2019_2

ORIGINALITY REPORT

11%	8%	8%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Qing-Chang Lu, Junyi Zhang, Lingling Wu, A. B. M. Sertajur Rahman. "Job and residential location changes responding to floods and cyclones: an analysis based on a cross-nested logit model", Climatic Change, 2016 Publication	2%
2	pwk.ft.undip.ac.id Internet Source	2%
3	hdl.handle.net Internet Source	1%
4	Submitted to Sriwijaya University Student Paper	1%
5	All Denicko Roynaldi, Maryono Maryono. "Estimation of Waste Generation from Tidal Flood in North Semarang Sub-District", E3S Web of Conferences, 2019 Publication	1%
6	www.woodplc.com Internet Source	1%

7	Nur, M, E Kusdiyantini, W Wuryanti, T A Winarni, S A Widyanto, and H Muharam. "Development of Ozone Technology Rice Storage Systems (OTRISS) for Quality Improvement of Rice Production", Journal of Physics Conference Series, 2015. Publication	1%
8	eprints.unm.ac.id Internet Source	<1%
9	www.fukuoka.unhabitat.org Internet Source	<1%
10	sciencedocbox.com Internet Source	<1%
11	docplayer.net Internet Source	<1%
12	Nurul Hidayah, Syafrudin. "A Review on Landfill Management in the Utilization of Plastic Waste as an Alternative Fuel", E3S Web of Conferences, 2018 Publication	<1%
13	tuengr.com Internet Source	<1%
14	allafrica.com Internet Source	<1%
15	www.mdpi.com	

Internet Source

<1%

16	console-game.info Internet Source	<1%
17	www.scribd.com Internet Source	<1%

Exclude quotes On

Exclude bibliography On

Exclude matches Off

JURNAL_CSC 2019_2

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10