# MANAGEMENT OF WASTE FROM NATURAL DISASTERS WORLDWIDE

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***ABSTRACT:*** *When natural disasters occur, a huge amount of various types of waste is generated. This post-disaster waste can be a major impediment to emergency life-saving aid and reconstruction. The purpose of this article is to show that after natural disasters the resulting waste can be reused.The experience of previous natural disasters shows that the waste caused by them is often managed in a general way, but still, and that substantial improvements can be made in case of future events. Disaster waste (DW) also presents various opportunities: it can contain valuable materials such as concrete, steel and wood, as well as various organic wastes that can be used for composting. This can be achieved either as a source of income or as materials for reconstructions, thus reducing the use of natural resources from exhaustible sources. Disasters can occur in both developed and developing countries, generating large amounts of disaster waste, including construction and demolition waste (CDW), which must be properly managed like other types of waste.. While developed countries are able to implement appropriate disaster waste management (DWM) strategies to facilitate the recovery processes of various materials, developing countries generally struggle to find the resources and expertise to develop such strategies and they must be helped. Worldwide, many countries have made various guidelines for the management of these types of waste. Japan, as a disaster-prone country, has suffered from various natural disasters and is always trying to improve DWM.Because of this, Japan can contribute to a proper DWM globally by using these experiences. DWM and general waste management are closely related, where normal waste management is not sufficient, it is very difficult to properly and efficiently manage waste caused by disasters. Improving overall waste management can lead to increased effectiveness of DWM in the event of natural disasters.*

***Keywords:*** *disaster; waste; management; reconstruction; materials;*

## Introduction

The earthquake in Turkey and Syria of magnitude 7.8 had its epicenter near the city of Gaziantep, one of the most affected cities, due to the vulnerability of the existing infrastructure and the little control in its construction processes. Hundreds of aftershocks of varying magnitudes continue to shake the devastated region.They are damaging the unstable buildings and other infrastructure further, and hamper rescue and relief efforts at the same time[1].Turkey and Syria are living a nightmare: The death toll from the earthquakes amounts to more than 21,000 deaths, after a new update of the balance of victims in both countries, the death toll from the earthquakes already amounts to 7,376 deaths and the number of injuries, to more than 78,000.

The natural disasters in this case, the earthquakes, have over time caused a lot of loss of human lives as well as immense material damage. The earthquake in Turkey occurred at 04:17 local time (01:17 GMT) at a depth of about 17.9 kilometers (11 miles) near the Turkish city of Gaziantep, which is home to about 2 million people, it said The United States Geological Survey.

It is one of the strongest earthquakes in the region in at least a century, and although Turkey has implemented measures to improve preparedness and response to seismic disasters, a lack of inspections is also causing many builders to ignore regulations.[2].

The earthquake is already considered the deadliest in 20 years and the most intense since 1939, which caused the absolute mobilization of emergency services in a territory that faces infrastructure problems and which, in addition, is one of the cities with the largest number of Syrian refugees.[3].

The damage caused by the devastating earthquake in Turkey could have been limited,

experts say.[4] Some structures in Turkey that were advertised as being built to modern seismic codes but did not withstand the earthquake.[4]

The damage makes the 2011 Great East Japan earthquake and tsunami the most expensive natural disaster in history. In Japan, the event resulted in the total destruction of more than 123,000 houses and damage to almost a million more. Ninety-eight percent of the damage was attributed to the tsunami[5]. The costs resulting from the earthquake and tsunami in Japan alone were estimated at $220 billion USD. As of December 2020, the Japan National Police Agency reported 15,899 deaths, 2,527 missing and presumed deaths, and 6,157 injuries for the Great East Japan event[6].

## Materials and Methods

In order to present a summary as accurate as possible of the amount of waste generated as a result of various natural disasters, various scientific works related to each disaster were studied and the data obtained were synthesized in a summary that shows the extent of these disasters. About 280,000 buildings in 11 provinces in southern Turkey collapsed or were severely damaged by the earthquakes.[8]. Early estimates from the United Nations Development Program (UNDP) indicate that the 7.8 magnitude disaster generated between 116 and 210 million tons of debris.

Compared to Japan's 2011 disaster, more than 120,000 buildings were destroyed, 278,000 were

Fig. 1. General view of the Japanese city of Otsuchi, three days after the March 11, 2011 earthquake [7]

Fig. 2. The aftermath of the earthquake in Turkey[9]

half destroyed and 726,000 were partially destroyed, according to the agency[10], generating approximately 31 million tons of debris [11]. Previous disasters show that up to 90% of building rubble can be recycled, while Japan reused around 81% of the debris left after the 2011 disaster[11]–[13]. Table 1 shows the approximate amount of waste resulting from earthquakes in different countries.

Table 1. Amount of waste resulting from earthquakes

| Country | Year | References | Milions tons of debries |
|---|---|---|---|
| Turkey/Syria | 2023 | [8] | 116-210 |
| Japan | 2011 | [11] | 31 |
| Italy | 2009 | [14] | 1.5-3 |
| China | 2008 | [15] | 380 |
| Haiti | 2011 | [16] | 23-60 |

As a comparison to understand the extent of the disaster caused, the debris from the earthquake in Turkey was "enough to cover the entire island of Manhattan - twice - in a layer of rubble three meters high" [17].

Disaster waste management should be systematized as an integrated system where disaster waste management processes have a well-established flow [18]. The environmental problems caused by the disposal and treatment of these wastes are almost impossible to estimate [19]. These as well as the economic ones following a disaster can be somewhat controlled not only by the reaction in case of a disaster, but also by the preventive measures taken in advance, this being valid for waste management in case of disasters [20]. Disaster management is usually composed of four phases, each of which equally contributes to good mana-gement in the event of a disaster: mitigation, preparation, relief and recovery [21].

## Results and discution

The potential to recycle or reuse the debris is sometimes overlooked in order to clear affected areas quickly. Commonly, the debris is dumped in overloaded landfills which can be costly, both economically and environmentally[22] In most cases, the waste is thrown away overloaded landfills that can be costly, both economically and environmentally [17, 18], but enormous quantities, such as that generated in Tohoku, are difficult to dump in a landfill for disposal, so it is vital to recycle as much as possible[23]

Japan has been influential in advancing the best practices for handling disaster debris. The Japan Society of Material Cycles and Waste Management (JSMCWM) suggest that recycling should be considered in the management of debris as it helps to put resources to use in the recovery and reconstruction process.

In its recommendations concrete debris is recycled for rebuilding, wood scraps can substitute for fossil fuels in power generation, scrap metal is recycled and tires are shredded to crumbs and recycled or incinerated [24]. 300 temporary storage sites used to deal with disaster waste were set up, only 100 were located in the Miyagi region. 29 temporary incinerators were made for combustible waste and 12 shredding and sorting facilities were used for non-combustible waste [25]

85% of the recycled concrete debris and tsunami deposits are planned for use within public works projects. These projects include the restoration of coastal embankments, disaster prevention forests and national parks[26]. Table 2 shows the public works projects planned for Miyagi prefecture located in the tsnunami affected area[27].

It was necessary of how the material damage of a natural disaster can be managed very well with extraordinary results.the creation of new technologies for the reuse of contaminated concrete rubble, as it would not meet the requirements Japanese industrial standards for recycled aggregates. Several entities, including construction companies from other related fields, universities and local administration, have

Table 2. The public works projects planned for Miyagi prefecture

| Project | Recycled Material | Amount (including planned use) |
|---|---|---|
| Coastal or river embankment restoration | Tsunami deposits Concrete debris | 103 |
| Coastal disaster-prevention forest restoration | Tsunami deposits Concrete debris | 110 |
| Agricultural field restoration | Tsunami deposits | 15 |
| Park construction | Tsunami deposits Concrete debris | 262 |
| Fishing port projects | Concrete debris | 29 |
| Construction of temporary storage sites | Tsunami deposits Concrete debris | 89 |
| Other projects | Tsunami deposits Concrete debris | 114 |

collaborated in the development of these new technologies or recycling/reuse procedures [26].

Precisely because of this tight collaboration between those involved, Japan is a world example of how the material damage of a natural disaster can be managed very well with extraordinary results.

## Conclusion

The competent authorities in Turkey and Syria have the example of Japan in terms of good organization and management of waste management, including their recycling and reuse after the Tsunami of 2011, this being comparatively the destruction was extremely destructive. Following the example of the city of Sendai in the area affected by the tsnunami, the entire region faced the two years of waste processing imposed by the Japanese government.

In addition, new technologies have been developed to use recycled materials, with the scraps being stored until they are ready for use in a public works project.

## References

[1] L. Dal Zilio and J.-P. Ampuero, "*Earthquake doublet in Turkey and Syria*," Commun. Earth Environ., vol. 4, no. 1, p. 71, Mar. 2023, doi: 10.1038/s43247-023-00747-z.

[2] "*Ingenieria y Construccion*," 2023. https://www.ingenieriayconstruccioncolombia.com/terremoto-turquia/

[3] "*El Confidencial*," 2023. https://www.elconfidencial.com/ mundo/2023-02-07/ radiografia-epicentro-terror-turquia-malas-construcciones_3571084/

[4] "*NYtimes.com/es*," 2023. https://www.nytimes.com/es/2023/02/15/espanol/turquia-terremoto-edificios.html

[5] "*On This Day: 2011 Tohoku Earthquake and Tsunami*." https://www.ncei.noaa.gov /news/day-2011-japan-earthquake-and-tsunami#:~:text=In Japan%2C the event resulted,estimated at %24220 billion USD.

[6] "*Tohoku Earthquake and Tsunami*." As of December 2020, the Japan National Police Agency reported 15,899 deaths, 2,527 missing and presumed deaths, and 6,157 injuries for the Great East Japan event

[7] "*Zece ani de la tripla catastrofă care a lovit Japonia: seism, tsunami şi accident nuclear*. Cum s-au desfăşurat evenimentele Citeşte mai mult la: https://www.digi24.ro/stiri/externe/ mapamond/zece-ani-de-la-tripla-catastrofa -care-a-lovit-japonia-seism-tsuna." https://s.iw.ro/gateway/g/Z mlsZVNvdXJjZT1odHRwJTNBJTJGJTJG/ c3RvcmFnZTA3dHJhbnNjb2Rlci5yY3Mt/cmRzLnJvJTJGc3RvcmFnZSUyRjIwMjEl/MkYwMyUyRjExJTJGMTI5OTMxMl8xMjk5/MzEyX090c3VjaGktSmFwb25pYS1jdXRy/ZW11ci10c

3VuYW1pLXNlaXNtLTExLW1h/cnRpZS0yMDExLUdldHR5SW1hZ2VzLTEx/MDExMTQyMi5qcGcmdz03ODAmaD00NDAm/aGFzaD02MDFmODEwZjViN2I3N2Q0MWU2Mzk0MzI2OTY3MjI3Yw==.thumb.jpg

[8] "*Newlinesmag.com*," 2023. https://newlinesmag.com/reportage/toxic -earthquake- waste-endangers-lives-in-turkey/

[9] "*Curemur Turcia*." https://perfecte.protv.ro/

[10] B. Oskin, "apan earthquake & tsunami of 2011: Facts and information," 2022. https://www.livescience.com/39110-japan-2011-earthquake-tsunami-facts.html

[11] "UNDP.org," 2023. https://www.undp.org/press-releases/millions-tons-earthquake-rubble-await-removal-turkiye

[12] V. W. Y. Tam, M. Soomro, and A. C. J. Evangelista, *"A review of recycled aggregate in concrete applications (2000–2017)*," Constr. Build. Mater., vol. 172, pp. 272–292, May 2018, doi: 10.1016/j.conbuildmat.2018.03.240.

[13] "*Reliefweb.int/report," 2023.* https://reliefweb.int/report/turkiye/japan-funds- recycling-facilities-earthquake-rubble-turkiye-entr

[14] F. Faleschini, M. Zanini, L. Hofer, and C. Pellegrino, *"Demolition waste management after recent Italian earthquakes*", [Online]. Available: https://www.researchgate.net/ publication/320307426_Demolition_waste_management_after_recent_Italian_earthquakes

[15] J. Xiao, H. Xie, and C. Zhang, "*Investigation on building waste and reclaim in Wenchuan earthquake disaster area*," Resour. Conserv. Recycl., vol. 61, pp. 109–117, Apr. 2012, doi: 10.1016/j.resconrec.2012.01.012.

[16] N. Domingo and H. Luo, "*Canterbury earthquake construction and demolition waste management: issues and improvement suggestions*," Int. J. Disaster Risk Reduct., vol. 22, pp. 130–138, Jun. 2017, doi: 10.1016/j.ijdrr.2017.03.003.

[17] "Asia.nikkei.com," 2023. https://asia.nikkei.com/Economy/Natural-disasters/ Turkey-set-to-recycle-quake-debris-covering-two-Manhattans

[18] T. Tabata, A. Onishi, T. Saeki, and P. Tsai, "*Earthquake disaster waste management reviews: Prediction, treatment, recycling, and prevention*," Int. J. Disaster Risk Reduct., vol. 36, p. 101119, May 2019, doi: 10.1016/j.ijdrr.2019.101119.

[19] Y. Wakabayashi, T. Peii, T. Tabata, and T. Saeki, *"Life cycle assessment and life cycle costs for pre-disaster waste management systems*," Waste Manag., vol. 68, pp. 688–700, Oct. 2017, doi: 10.1016/j.wasman.2017.06.014.

[20] F. He and J. Zhuang, "Balancing pre-disaster preparedness and post-disaster relief," Eur. J. Oper. Res., vol. 252, no. 1, pp. 246–256, Jul. 2016, doi: 10.1016/j.ejor.2015.12.048.

[21] B. R. Lindsay, "*Social media and disasters: Current uses, future options, and policy considerations,*" 2011. [Online]. Available: https://nsi.org/ReferenceLibrary/983.pdf

[22] R. Poudel, Y. Hirai, M. Asari, and S. Sakai, "*Field study of disaster waste management and disposal status of debris after Gorkha Earthquake in Kathmandu, Nepal*," J. Mater. Cycles Waste Manag., vol. 21, no. 4, pp. 753–765, Jul. 2019, doi: 10.1007/ cs10163-019-00835-3.

[23] C. Brown, M. Milke, and E. Seville, *"Disaster waste management: A review article*," Waste Manag., vol. 31, no. 6, pp. 1085–1098, Jun. 2011, doi: 10.1016/j.wasman. v2011.01.027.

[24] "Debris Management." https://www.gfdrr.org/sites/default/files/publication/ knowledge-note-japan-earthquake-4-4.pdf

[25] "*Treatment of debris in coastal municipalities of the three most affected prefectures by the Great East Japan Earthquake*." https://www.env.go.jp/content/000043872.pdf

[26] T. R. Norton and O. Murao, "DEBRIS MANAGEMENT AND RESTORATION OF THE MIYAGI PREFECTURE AFTER THE 2011 TOHOKU EARTHQUAKE AND TSUNAMI," in 16th World Conference on Earthquake Engineering. [Online]. Available: https://www.wcee.nicee.org/wcee/article/16WCEE/WCEE2017-4166.pdf

[27] "*Ministry of the Environment, Debris Processing Sites*." http://kouikishori. env.go.jp/data/