



# Management of Plastic Waste in a Refugee Camp, Environmental Challenges and Issues: Case of the Minawao Refugee Camp (Cameroon)

Paul Kodji<sup>1,\*</sup>, Tchobsala<sup>1</sup>, Adamou Ibrahima<sup>2</sup>, Ayouba Bulus<sup>3</sup>

<sup>1</sup>Department of Biological Sciences, University of Maroua, Maroua, Cameroon

<sup>2</sup>Department of Biological Sciences, University of Ngaoundéré, Ngaoundéré, Cameroon

<sup>3</sup>Department of Earth Sciences, University of Ngaoundéré, Ngaoundéré, Cameroon

## Email address:

paulkodji@yahoo.com (P. Kodji)

\*Corresponding author

## To cite this article:

Paul Kodji, Tchobsala, Adamou Ibrahima, Ayouba Bulus. Management of Plastic Waste in a Refugee Camp, Environmental Challenges and Issues: Case of the Minawao Refugee Camp (Cameroon). *International Journal of Engineering Management*. Vol. 5, No. 2, 2021, pp. 37-43. doi: 10.11648/j.ijem.20210503.12

**Received:** August 29, 2021; **Accepted:** September 11, 2021; **Published:** November 19, 2021

---

**Abstract:** The arrival of refugees in a country increases the difficulty of managing plastic waste. The problem of recycling plastic waste remains a major challenge for the global community, especially in developing countries like Cameroon. This study examined the use of plastic waste by refugees to understand their knowledge of local plastic waste management. To do this, a socio-economic survey was carried out in the refugees' households. This survey provided an insight into the plastic waste management practice in the camp. The survey revealed that the refugees in Minawao do not have enough knowledge about the importance of plastic waste management. These refugees throw plastic waste in rivers, at the roadside or form a dustbin near the house. It has been noticed in the Minawao refugee camp that the harmful effects of plastic waste are beginning to be visible. The reduction of environmental pollution in this camp requires awareness raising and training of refugees on plastic waste management, promotion of sustainable plastic waste management technologies, and funding of plastic waste management projects. These measures should be the individual responsibility of each actor for a participatory management. The initiation of local projects in the manufacture of plastic paving stones and bricks can reduce the proliferation of plastic waste in nature. The action of local and international companies and the environmental policy of Cameroon are all necessary to prevent environmental disaster. These measures need to be extended to all towns bordering Minawao.

**Keywords:** Cameroon, Minawao, Refugees, Plastic Waste

---

## 1. Introduction

Pollution and contamination are among the most widely discussed environmental issues in recent times [1–3]. According to these authors, these issues affect many countries in the world. The inadequacy and inefficiency of our current waste management system to cope with the increased reliance on plastic is exacerbating its mismanagement and escape into the environment [1]. However, good waste management has positive impacts on the environment, human health and the country's economy [4]. When solid waste is not managed, it leads to severe environmental pollution with adverse effects on human

health and the environment. Decomposition of solid waste in open spaces, uncontrolled dumping or drainage by stormwater are likely to have negative environmental impacts, including soil, water and air pollution [5, 6].

Waste management in Africa is often characterised by dumping and open burning [7, 8]. In most African capitals, less than 30% of waste is disposed of [9, 10]. The remaining 70% of waste is dumped in gutters and on the streets. As mentioned by Hebette [11], this insufficient collection rate has consequences on the health of the population and on the urban economy. The impacts of plastic waste are most visible in environments with high concentrations of human populations and where waste treatment services are absent or

inadequate. The impacts of this waste have adverse effects on the soil and make the soil poor [12]. In IDP camps in host countries, plastic waste is less managed due to the lack of resources allocated to its management and the lack of effective mechanisms especially in developing countries.

The majority of the world's continents, including Africa in particular, have long been confronted with environmental problems in refugee settlements due to various conflicts [12]. According to the United Nations High Commissioner for Refugees (UNHCR), the number of people forced to leave their homes reached nearly 60 million in the second half of 2015 [13]. The reasons for this are natural disasters such as droughts, floods and land degradation caused by climate change as well as social factors such as poverty, lawsuits and armed conflicts [14]. Especially in Africa and the Middle East, camps and temporary settlements have been a widespread phenomenon since the last century [15]. The high concentrations of these displaced people cause large quantities of household waste due to lack of proper treatment, resulting in soil and groundwater pollution [16]. The impacts of plastic waste in refugee camps could also transform vegetation. A study in Bangladesh showed that about 21,409.12 ha (37.46%) of land cover of the entire study area was transformed in three decades (1990-2020) and about 2,495.63 ha (4%) of land was transformed just for the Rohingya refugee camps [17]. Bare soil and evidence of erosion are indicators of land degradation [18].

The Minawao refugee camp is home to nearly 64,000 refugees [19]. These Boko Haram conflict refugees reside in shelters made of thin plastic sheeting with poor living conditions and are often vulnerable to rainfall [20, 12]. These refugees depend on donations from humanitarian organisations [21]. As elsewhere in the developing world, plastic waste from households in this camp is poorly managed and is a direct cause of pollution [3]. Macro, micro and nano plastics have polluted the earth's soil, freshwater and oceans [22], and such pollution kills wildlife, damages natural ecosystems and contributes to climate change [23]. As such, it is interesting to note that environmental policy could legitimately seek to find appropriate solutions to environmental deterioration in areas where refugees are clustered. The main objective of the study is to raise awareness for local management of plastic waste to reduce environmental risks caused by plastic waste.

## 2. Materials and Methods

### 2.1. Location of the Study Area

The study was carried out in Minawao, a village in the Canton of Zamay, which is located in the Far North Region of Cameroon, specifically in the Department of Mayo Tsanaga, between  $10^{\circ}33'38''$  north latitude and  $13^{\circ}51'25''$  east longitude, at an altitude of 595 m [24] (Lindsey, 2015). Established by the Cameroonian government and UNHCR as a refugee camp on 2 July 2013, the Minawao Refugee Camp covers over 31900 ha and is home to nearly 64000 refugees [19]. The

Camp is organised into 88 blocks and its governance is provided by a refugee chief who represents all refugees to the authorities [21] supported by 88 block leaders. There are two police stations. Located about 30 km from Mokolo, Minawao is bounded by four villages namely: to the north by the centre of Zamay; to the south by Gawar, to the east by Gadala and to the west by Sabongari [24] (figure 1).

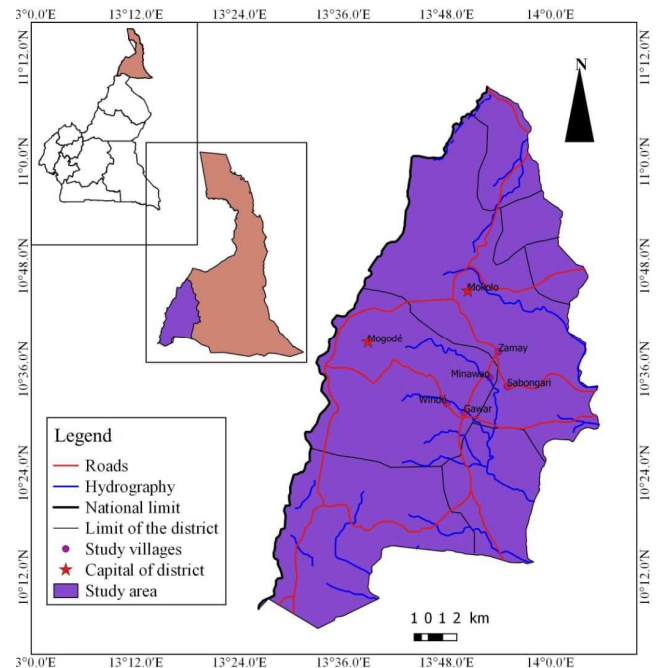


Figure 1. Location map.

### 2.2. Physical Environment

#### 2.2.1. Climate

The climate of the area is Sudan-Sahelian. The locality has a long dry season with an average duration of 7 months, from November to May. The only rainy season (June to October) is characterised by heavy rains centred on the months of August and September. The rainy season begins with the southwest monsoon, after the rise of the Inter-Tropical Front (ITF) [25]. The average annual rainfall is 950-1000j mm with an average of 60 rainy days per year and the temperature for its part is highest during the months of March ( $23.90^{\circ}\text{C}$ ) and April ( $23.70^{\circ}\text{C}$ ) (Figure 2) [21].

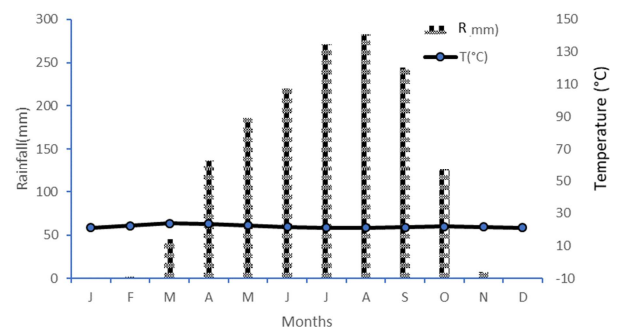


Figure 2. Umbrothermal diagram of Mokolo from 2000 to 2019 (Source: Mayo Tsanaga Agricultural Delegation, June 2020).

### 2.2.2. Pedology

The soils are essentially represented by weakly evolved arenas and soils with a hydromorphic tendency in the alluvial lowlands, due to a sometimes poorly hierarchical hydrographic network [26]. The arenas are the main characteristic of the massif from a pedological point of view, apart from the soils of the peneplain flats which tend towards tropical ferruginous soils [26]. The soil types found in the region are: lithosols, lithosolic erosional soils, poorly developed contributory soils on pediments, poorly developed alluvial contributory soils, developing soils on acidic bedrock, developing soils on basic bedrock, and mineral hydromorphic soils on alluvium [19].

### 2.2.3. Relief

The relief of the region is marked by a set of high-altitude plateaus characteristic of the Mandara Mountains regions, which are part of the mountainous massifs making up the Cameroonian ridge [20]. The relief is uneven. It has an average altitude of 1,000 m, and innumerable rocky peaks. Most of the plateau is made up of migmatites and some granites punctuated by intrusions of acid and basic volcanic rocks [27].

### 2.2.4. Vegetation

In this locality, no primary vegetation formation as such remains. It is dominated by shrubs and woody plants, most of which are thorny. In general, it is made up of species such as *Acacia albida*, *Acacia seyal*, *Acacia nilotica*, *Ficus* spp, *Tamarindus indica*, *Azadirachta indica*, *Anogeiosus leiocarpus*, *Ziziphus mauritiana*. These species are mainly used as shade trees in the fields, as a source of firewood and timber. This vegetation is undergoing a strong deterioration due to population growth and the abusive cutting of firewood and service wood [26, 12].

## 2.3. Collection of Socio-economic Data

The analysis and observations were carried out with the participation of a large number of diverse stakeholders. Semi-structured interviews were carried out with the populations, using a pre-established questionnaire. The questionnaire consisted of three types of questions: open-ended questions in which the respondent expressed his or her opinion freely; closed-ended questions to be answered by Yes or No; and guided questions in which the respondent chose one or more answers. The aim of these surveys is to find out about the different forms of local management of plastic waste in each household. The different actors met are the following:

United Nations agencies (UNHCR, UNICEF, UNDP, OCHA);

International organisations (ACF, PUI, French Red Cross, IFRC, etc.);

Civil society organisations (Cameroonian Red Cross, Public Concern, ACEEN, etc.);

Heads of households in the refugee camp.

Representatives of local and national authorities, as well as technical departments (Ministry of Forests and Wildlife,

Ministry of Water and Energy, Ministry of the Environment, Nature and Sustainable Management, the administrator representing the State in the camp, etc.). The survey took place during the dry season, a period during which the majority of the surveyed populations are at home [28, 12]. The surveys were conducted randomly from 4 January to 29 April 2018 among the targets. At the end of these surveys, 1587 people were interviewed.

## 3. Results and Discussion

### 3.1. Use of Household Waste Bins by Refugees

Figure 3 shows the use of bins by refugees. From this analysis it can be seen that the majority of households (94%) do not have bins. About 6% of households use bins. Refugees do not think about the effects of waste on the environment. Some household waste is disposed of by the inhabitants themselves (burnt in chimneys). According to the humanitarian organisations interviewed, rubbish bins are distributed to the refugees but they use them for other purposes. In this refugee camp, there are no plastic waste processing services and it is difficult to get single-use plastic [29, 30]. For this reason, the existence of bins cannot solve the problem of the proliferation of this waste in the environment [31]. Once the bins are filled, this waste from the bins is released into the environment, which can lead to soil contamination. A recent study found that biodegradable and oxo-biodegradable plastic formulations persisted and remained functional in soil and marine environments even after three years [1]. It is important to encourage investment in product development for both hygiene and recycling. This may lead to innovations in current product design to make them suitable for multiple uses after washing or disinfection [32, 1].

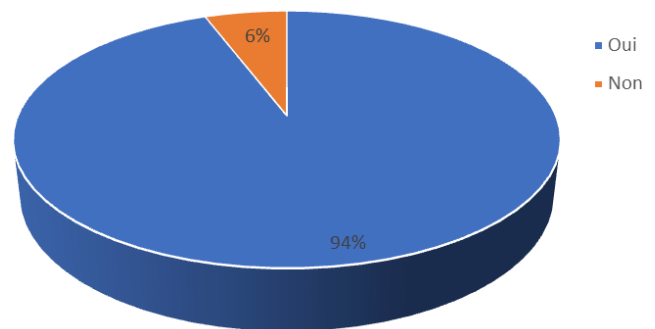


Figure 3. Percentage use of household waste bins by refugees.

### 3.2. Waste Disposal Sites by Populations

Figure 4 shows the different waste disposal sites of the refugees in Minawao. It can be seen that the majority of waste is unloaded in markets (37, 70%). The accumulation of waste in a town causes problem that degrade the living environment: foul odors, larvae breeding sites, air, water and soil pollution, etc. Moreover, this accumulation of waste affects the natural environment. If the environment is



contaminated, this can lead to substances produced by soil leaching from plastic waste contaminating ground and surface water sources, aggravating the lack of access to drinking water and sanitation. The accumulation of plastic waste unbalances the normal circulation of water in the soil and slows down the activities of micro-organisms. In Guinea, studies on the impact of landfills in Labé [33] and Conakry [34], for example, have shown that the soil around landfills is contaminated. How to dispose of these multiple quantities of household waste in a profitable manner and without causing damage to the environment and human health. Recycling practices in Cameroon are still at an embryonic stage and people find it easier to throw plastic waste carelessly by the roadside or into the river (Figure 4). The lack of available technology, high operating and recycling costs are the reason for dumping plastic waste in rivers, along roadsides or dumping it at homes [35].

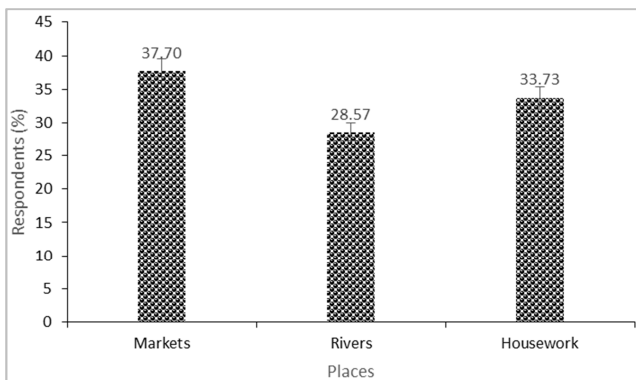


Figure 4. Waste disposal mode by refugees.



Source: Field survey, July 2020

Figure 5. Landfill at water crossing.

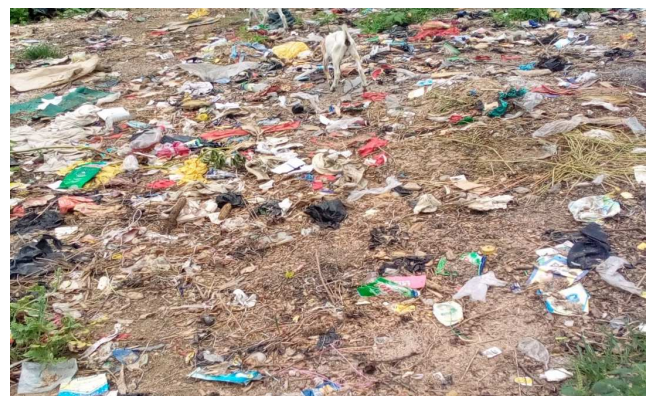
Discharge of waste close to houses can block the passage of water. Over time, this can lead to flooding in the camps. As shown in Figure 5, the passage of water has been blocked by the waste bin. During the heavy rainy season, this water can cause damage to crop fields and houses. Efficient mechanical recycling of plastics requires a functional improvement of all sectors of the plastics value chain [36]. As landfills and waste dumps promote material and energy loss [37], efforts should be made to significantly reduce their use. The majority of plastic waste in rivers near Minawao camp was found to have washed away during the rainy season (Figure 5). By 2050, it is estimated that there will be more plastic in the world's oceans than fish [38]. Thus, better

management of plastic waste in the Minawao refugee camp requires the coordination of the different actors in the sector. This organisation requires first of all the commitment of all humanitarian, public and private actors. the existence of frank collaboration between them through the establishment of policies that strengthen synergy and allow the development of waste recycling services.

### 3.3. Environmental Contamination by Plastic Waste

The populations surveyed indicate that plastic products generally come from the neighbouring country Nigeria. More than 90% of plastics leave Nigeria according to the people. It was observed at the study site that the majority of packaging coming from this neighbouring country is made of plastic.

According to the refugees, the soil around the camp is contaminated by plastic waste. This contamination is reflected in the change of colour of the soil. In addition, the water and rivers are also contaminated by this waste. The dumping sites of this waste show a change over time. The irregular collection of waste leads to a proliferation of illegal and uncontrolled dumping in cities (Figure 6). Soil contamination is a fundamental issue not only because it affects our environment but also and especially because it affects water. The results of Gerolin et al [39] show the ubiquity of microplastics in all the sediments sampled and serve as a contamination fingerprint for the Negro and Amazon rivers in Brazil. Similarly, Donoso and Rios-Touma [40] found microplastic contamination in the upper basin of the Guayllabamba River, which is a biodiversity hotspot. What plastic waste means for plant diversity.



Source: Field survey, July 2020

Figure 6. Contamination of landfill sites.

### 3.4. Methods of Managing Plastic Waste

The management of household solid waste is an ongoing concern in many large African cities. The most common plastic waste management techniques used around the world are mechanical recycling, incineration and landfilling. The Ellen McArthur Foundation estimates that the mechanical recycling rate of plastic waste worldwide is 16%. In comparison, other plastic waste is either incinerated (25%), landfilled (40%) or escapes into the environment due to poor management (19%) [41]. In the Minawao refugee camp, the

majority of plastic waste escapes into the environment. The lack of recycling services for plastic waste in developing countries is an obstacle to waste management. It is important that the Cameroonian government and organisations fund plastic waste management projects in the Minawao camp. For this reason, the government of Guinea allocates an annual budget of 6 billion Guinean francs for sanitation [42].

In the Minawao refugee camp, there is no waste recycling service. As a result, waste is deposited everywhere in the wild. For this reason, there is a need to adopt efficient business models for waste collection and separation (Kumar et al., 2020). In Cameroon, there are companies involved in the manufacture of plastic paving stones (Figure 7). It is in the economic capital of Cameroon (Douala) that Roger Milla's company is involved in the recycling of plastic waste. This is the process where waste is used to explore its potential by reusing it or transforming it into useful materials. This procedure was developed to address constraints on plastic waste management [43] but is not present in the Minawao refugee camp [12]. As part of a long-term strategy to improve the efficiency of plastic waste recycling, policies should be formulated to reduce multi-layered packaging and to promote homogeneous plastic packaging materials that are easier to recycle.



Source: Field survey, December 2020

**Figure 7.** Paving stones made from plastic waste.

Raw material recycling can also work better even if the waste is only slightly contaminated with organic material, so it can be a more sustainable solution than incineration or landfilling of plastic waste [44]. The manufacture of plastic bricks is also recommended to reduce the proliferation of plastic waste [3]. As waste is everybody's business, all stakeholders must be effectively involved in its management. Cooperation of all stakeholders in the Minawao refugee camp is necessary for a more rational and efficient consideration of plastic waste management issues. Clear identification of stakeholders and their roles and involving them in plastic waste management programs from design through to implementation and decision-making processes. In addition, communication and awareness-raising campaigns for the refugees of Minawao are needed to promote a real culture of cleanliness through meetings, conferences, etc. and the

organisation of competitions for the cleanest houses.

## 4. Conclusion

Plastic waste management in the Minawao refugee camp remains a challenge for Cameroon and non-governmental organisations. The refugees in Minawao have no idea about the negative effects of plastic waste. In this refugee camp, there is no plastic waste recycling service. The lack of funding for the recycling project is of concern to the various humanitarian actors. There is a need for integrated waste management involving a holistic approach that takes into account the various concerns of sustainable development: environmental, economic and social. Refugees also need to be trained in plastic waste management. It is necessary for donors to initiate projects in the manufacture of plastic paving stones and bricks in this refugee camp.

## Funding Information

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Declaration of Competing Interest

The authors declare that they have no conflict of interest with regards to the manuscript.

## Acknowledgements

I could not finish this work without thanking the traditional, administrative authorities and the local populations of Minawao.

## References

- [1] Kumar, R. V., Hari, B. S., Ved Prakash R., Biswajit, S., Bhattacharya J., Brajesh, K. D., and Sudha G., 2020. Challenges and strategies for effective plastic waste management during and post COVID-19 pandemic. *Science of the Total Environment* 750 (2021) 141514. <https://doi.org/10.1016/j.scitotenv.2020.141514>.
- [2] Temitope, D., Oyedot T. and Nasrudeen A., 2021. Environmental issues and challenges confronting surface waters in South America: A review. *Environmental Challenges*, 3 (2021) 100049. <https://doi.org/10.1016/j.envc.2021.100049>.
- [3] Sazzadul, Md. H. and Shabab I., 2021. Effectiveness of waste plastic bottles as construction material in Rohingya displacement camp. *Cleaner Engineering and Technology*, 3 (2021) 100110. <https://doi.org/10.1016/j.clet.2021.100110>.
- [4] Rybaczevska-Baaniejowska, M., 2013. Economic, Environmental and Social Aspects of Waste Management – the LCA Analysis. *Pragmata tes Oikonomias*, 7: 239-250. [http://dlibra.bg.ajd.czest.pl:8080/Content/1267/Pragmata\\_7\\_2\\_0.pdf](http://dlibra.bg.ajd.czest.pl:8080/Content/1267/Pragmata_7_2_0.pdf).

- [5] Kafando, P., Segda, B. G., Nzihou, J. F. and Koulidiati, J., 2013. Environmental Impacts of Waste Management Deficiencies and Health Issues: A Étude de Casin the City of Kaya, Burkina Faso *Journal of Environmental Protection*, 4 (10): 1080-1087. <http://dx.doi.org/10.4236/jep.2013.410124>.
- [6] Sankoh, F., Yan, X. and Yen, T., 2013. Environmental and Health Impact of Solid Waste Disposal in Developing Cities: A Étude de Cas of Granville Brook Dumpsite, Freetown, Sierra Leone. *Journal of Environmental Protection*, 4 (7): 665-670. <http://dx.doi.org/10.4236/jep.2013.47076>.
- [7] Mwesigye, P., Mbogoma, J., Nyakang'o, J., AfariIdan, I., Kapindula, D., Hassan, S. and Van Berkel, R., 2009. Africa review report on waste management. Main Report. Integrated assessment of present status of environmentally-sound management of wastes in Africa. Prepared for UNIDO, Addis Ababa. <http://www1.uneca.org/Portals/3/documents/AfricanReviewReportonWasteManagementMainReport.pdf>.
- [8] Mohammed, Y. S., Mustafa, M. W., Bashir, N., Mokhtar, A. S., 2013. Renewable energy resources for distributed power generation in Nigeria: A review of the potential. *Renewable and Sustainable Energy Reviews*, 22: 257-268. <https://doi.org/10.1016/j.rser.2013.01.020>.
- [9] Adepoju, G. O., 2002. La gestion des déchets urbains: des solutions pour l'Afrique, Paris, Ottawa, Editions Karthala et CRDI, 250 p.
- [10] Bontianti, A., and Sidikou, A. H., 2008. Gestion des déchets à Niamey, Edition l'Harmattan, 122 p.
- [11] Hebette, A., 1996. Guide pratique de la gestion des déchets solides urbains en Afrique Subsaharienne, IAGU-GREA. ISBN 2-1919894-02-1, Banque Mondiale, 154 p.
- [12] Kodji P., Tchobsala and Ibrahima A., 2021. Impacts of refugees and climate change on agricultural yields in the Sahelian zone of Minawao. Cameroon, *Environmental Challenges*, 4 (2021) 100108.
- [13] UNHCR. World at war. Global Trends 2014. United Nations High Commissioner for Refugees, Field Information and Coordination Support Section, Division of Programme Support and Management, Switzerland; 2015.
- [14] Lang, S., Füreder, P., Kranz, O., Card, B., Roberts, S., Papp, A., 2015. Humanitarian emergencies: Causes, traits and impacts as observed by remote sensing. In: Thenkabail P, editor. *Remote Sensing Handbook*, New York: Taylor and Francis. pp 483-512.
- [15] Castles, S., Miller, M., Ammendola, G., 2009. The age of migration: International population movements in the modern world. 4<sup>th</sup> ed. New York: Palgrave Macmillan.
- [16] UNHCR, 1991. Some Environmental Considerations in Refugee Camps and Settlements, Rapport, vol. 10, pp. 1-4.
- [17] Hossain F. and Md Moniruzzama, 2021. Environmental change detection through remote sensing technique: A study of Rohingya refugee camp area (Ukhia and Teknaf sub-district), Cox's Bazar, Bangladesh, *Environmental Challenges*, vol. 2, no. (2021) 100024, 2021.
- [18] Rabiou H, Mahamane M, Issaharou-Matchi I. 2019. Impact de L'installation des Camps des Réfugiés, Retournés et Déplacés sur l'exploitation des Ressources Ligneuses dans la Région de Diffa. *European Scientific Journal*, Edition 2019, 15 (36): 1857- 7431.
- [19] Max L. 2016. Le Cameroun face au terrorisme: la bombe à retardement de Minawao, *Le Monde*, 5 (2): 501-582.
- [20] Tchobsala, Kodji P., Ibrahima A. and Haiwa A., 2018. Impacts of refugee settlement on the plant dynamics and sustainable management of the environment of Minawao Camp, Far North, Cameroon, *Int. J. Adv. Res. Biol. Sci.*, vol. 5, no. 4, pp. 5-7, 2018.
- [21] Samantha, B., Bolivard, E., 2017. L'impact environnemental du Camp de réfugiés de Minawao: La crise migratoire a l'Extrême nord du Cameroun et prise en compte de l'environnement par les acteurs humanitaires. Groupe u.r.d., No 2, Cameroun, 64p.
- [22] Advisors, D., de Wit, W., Hamilton, A., Scheer, R., Stakes, T., Allan, S., 2019. Solving Plastic Pollution through Accountability. WWF International, Gland. <https://wwf.fi/mediabank/12129.pdf>.
- [23] UNEP, 2016. Marine Plastic Debris and Microplastics – Global Lessons and Research to Inspire Action and Guide Policy Change. United Nations Environment Programme, Nairobi. <https://wedocs.unep.org/rest/bitstreams/11700/retrieve>.
- [24] Lindsey H. 2015. On the border and in the crossfire: Cameroon's war with Boko Haram, *The Guardian*, 12 (7): 123-150.
- [25] Djarmaila. 2011. Médias et gestions des crises de la région de l'Extrême Nord du Cameroun: Cas de l'épidémie de choléra dans le Département du Mayo-Tsanaga. Master Professionnel. Université de Maroua (Cameroun), 2010-2011, 123 p.
- [26] Seignobos C., 1982. Nord Cameroun, montagnes et hautes terres (Architectures traditionnelles. Éditions parenthèses. 192 p.
- [27] PI (Plan International), 2016. Cameroun: Plan international offre 5 000 kits aux enfants scolarisés réfugiés du camp de Minawao, sur [www.mediaterre.org](http://www.mediaterre.org) (consulté le 27 mai 2020) - Médiaterre.
- [28] Martin D. and Segalen P., 1995. Ethnobotany. A method manual, Kew, Royaume-Uni, Royal botany Gardens, Londres, Chapman and Hall, 268p.
- [29] Xanthos, D., Walker, T. R., 2017. International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): a review. *Mar. Pollut. Bull.* 118, 17-26. <https://doi.org/10.1016/j.marpolbul.2017.02.048>.
- [30] Heidbreder, L. M., Bablok, I., Drews, S., Menzel, C., 2019. Tackling the plastic problem: a review on perceptions, behaviors, and interventions. *Sci. Total Environ.* 668, 1077-1093. <https://doi.org/10.1016/j.scitotenv.2019.02.437>.
- [31] Schnurr, R., Alboiu, V., Chaudhary, M., Corbett, R., Quanz, M., Sankar, K., Srain, H., Thavarajah, V., Xanthos, D., Walker, T., 2018. Reducing marine pollution from single-use plastics (SUPs): a review. *Mar. Pollut. Bull.* 137, 157-171. <https://doi.org/10.1016/j.marpolbul.2018.10.001>.
- [32] Aloueimine, S. O., 2006. Méthodologie de caractérisation des déchets ménagers à Nouakchott (Mauritanie): Contribution à la gestion des déchets et outils d'aide la décision. Thèse de Doctorat de l'Université de Limoges, 195p.

- [33] Abdelli D., 2005. Incidences environnementales de la décharge non contrôlée de la capitale régionale Labé et mesures d'atténuation, Thème présenté comme exigence partielle du master en sciences de l'Environnement, Centre d'Étude et de Recherche en Environnement (CERE), Université Gamal Abdel Nasser de Conakry, République de Guinée, 135p.
- [34] Toure S., 2010. Incidence de la décharge de la Minière à Conakry sur les milieux récepteurs et la santé des populations riveraines, Mémoire présenté comme exigence partielle du diplôme de master en sciences de l'environnement, Centre d'étude et de recherche en environnement, Université Gamal Abdel Nasser de Conakry, Guinée, 93p.
- [35] Mourshed, M., Masud, M. H., Rashid, F., Joardder, M. U., 2017. Towards the effective plastic waste management in Bangladesh: a review. *Environ. Sci. Pollut. Res.* <https://doi.org/10.1007/s11356-017-0429-9>.
- [36] Leissner S. and Ryan-Fogarty Y., 2020. Challenges and opportunities for reduction of single use plastics in healthcare: a case study of single use infant formula bottles in two Irish maternity hospitals, *Resour. Conserv. Recycl.*, vol. 151, no. 2019104462.
- [37] Vanapalli K., Samal B., Dubey B. and Bhattacharya J., 2019. Emissions and Environmental Burdens Associated with Plastic Solid Waste Management", pp. 313–342.
- [38] EDN, 2018. Plastic pollution primer and action toolkit: end plastic pollution. Earth Day Network. <https://www.earthday.org/wpcontent/uploads/Plastic-Pollution-Primer- and-Action-Toolkit.pdf>.
- [39] Gerolin, C. R., Pupim, F. N., Sawakuchi, A. O., Grohmann, C. H., Labuto, G., Semensatto, D., 2020. Microplastics in sediments from Amazon Rivers. Brazil. *Sci. Total Environ.* 749, 141604. doi: 10.1016/j.scitotenv.2020.141604.
- [40] Donoso, J. M., Rios-Touma, B., 2020. Microplastics in tropical Andean rivers: a perspective from a highly populated Ecuadorian Basin without wastewater treatment. *Heliyon* 6 (7), e04302. doi: 10.1016/j.heliyon.2020.
- [41] Ellen MacArthur Foundation, 2008. The New Plastics Economy: Rethinking the Future of Plastics & Catalysing Action, New Plastic Economy, <https://doi.org/10.2443/skv-s2013-51020130303>, 2017.
- [42] MEDD (Ministère guinéen de l'Environnement et du Développement Durable), 2010. Cadre de gestion des déchets solides de la ville de Conakry, Août 2009, 6p.
- [43] Wahid S. A. Rawi S. M. and Desa N. M., 2015. Utilization of plastic bottle waste in sand bricks, *J. Basic. Appl. Sci. Res.*, vol. 5, no. 1, pp. 35–44.
- [44] Hopewell J., Dvorak R. and Kosior, 2009. Plastics recycling: challenges and opportunities. *Philosophical Transactions of the Royal Society B, Biological Sciences*, vol. 364, pp. 2115–2126.