Instant Cities and Their Impact on the Environment: Al Zaatari Case Study

Ibrahim Zakarya Kaddour, Rawan Khattab, Amro Yaghi, and Lubna Alawneh

Abstract

Conflicts in the Arab world have produced multiple waves of refugees in the past decades. Jordan amongst has received a massive number of refugees located in different camps and considered to be the heaven of refugees. The new state of the camp became negatively impacting the host country and the environment in different layers. This research identified these various layers of impact; water, waste, electricity, soil, medical waste and social, which may not meet the sustainability requirements, disregarding their use as temporary panacea. This study aims at tracing the various environmental layers of impact in Al Zaatari camp. The paper then moves to focus on suggesting sustainable development tactics for each of these identified layers of impact. The methodology that has been used, to identify the various layers of impact and recommending their sustainable solutions or approaches, through tracing the literature and looking at other case studies related to our case. Finally, the paper concludes through generating some reflections about the identified layers and their solutions, recommending what is needed to be done to enhance the current camp status quo as well as future instant cities.

Keywords

Zaatari • Environmental impact • Sustainable development

1 Introduction

Forced migration is the mechanical response of refugees generated by natural disaster or external force, usually for the purpose of seeking better life conditions as the current situation is unbearable (Cohen, 1991; El-Hinnawi, 1985; McGregor, 1996; Renaud et al., 2011; Wilkinson et al., 2016). The 2011 political conflict in Syria has forced many citizens to immigrate in different countries across the world (Ledwith, 2014). On 28 July 2012, in the capital city of Mafraq Governorate in Jordan located 80 km to the north from the capital Amman, opened the second world's largest Syrian refugees camp (Al-Rai, 2012; Dalal, 2020; Ledwith, 2014). The initial plan was capped at 15,000 persons, but soon this number has multiplied more than 10 times and reached 200,000 in May 2013 (Dalal, 2014; 2020). Yet, the camp has already 8000 tents, 17,000 caravans, 120 mosques, 3 hospitals, 680 large shops and spread on 530 hectares (Abu Al-Sha'r, 2017; Al-Makhadhi, 2013; Betts et al., 2013; Khandaji & Makawi, 2013; Ledwith, 2014).

This has resulted in a chaotic situation and the birth of instant city. Both the United Nations High Commissioner for Refugees (UNHCR) and the Jordan Hashemite Charity Organisation (JHCO) who created this camp have no plan to face the developed situation (Ledwith, 2014; Scheel & Ratfisch, 2014). However, UNHCR took full responsibility and responded to the challenges faced on the ground by imposing many humanitarians' disciplinary plans (Dalal, 2014). First, there was a decomposition of the camp into 12 small districts using asphalt streets to clearly determine the boundaries. These districts are composed of blocks that contain caravans in a homogeneous order (Dalal, 2020). After that, the

I. Z. Kaddour (✉)
University of Portsmouth, Portsmouth, UK
e-mail: Ibrahim.kaddour@port.ac.uk

R. Khattab
Spatial Planning, Amman, Jordan

A. Yaghi
University of Petra, Amman, Jordan
e-mail: amro.yaghi@uop.edu.jo

L. Alawneh
Bauhaus University Weimer, Weimer, Germany

B.-J. He et al. (eds.), *Climate Change and Environmental Sustainability*, Advances in Science, Technology & Innovation,
https://doi.org/10.1007/978-3-031-12015-2_22

implementation of basic home facility's needs, such as the communal latrines, kitchens, and multi-use spaces (Ledwith, 2014; Scheel & Ratfisch, 2014). Finally, for a better camp's management, there were two distinctive areas planned to control the flow of the incoming refugees. One of these areas was like a waiting room for the new arriving refugees, and the second was where the final allocation for settlement. However, soon this plan collapsed due to the socio-cultural relationship amongst families. Syrian refugees moved their shelters around the camp resulting in change of the surface area on a daily basis (Dalal, 2020).

Due to the reason behind the necessity to survive in a dignified manner (Bayat, 1997), the camp became out of control, houses made out of metal sheets, canvas bags, Styrofoam, wooden pieces, metal nets, and water tanks (Dalal, 2020). This is mainly due to the fact that UNHCR provides these refugees with only one-space shelter unit for several members of family, which has broken the respect, and results in a discomfort expression amongst members of the family that is eminent. Young daughter had to change her clothes in front of her brothers, a situation that never happened back home country (Dalal, 2020). In addition to the poor design of the camp and the lack of skills amongst refugees, the severity of local climate and water shortage in the country has intensified the disorder of the camp. The new state of the camp became very harmful to the surrounding areas and negatively impacted the host country and the environment in different layers (Alshoubaki, 2017). Therefore, this research aims at tracing the various environmental layers of impact in Al Zaatari camp, suggesting sustainable solutions.

2 The Layers of Impacts

2.1 Water

Regardless, there is no formal building code that clearly states the refugees' camps in Jordan can or cannot be temporarily implemented in the country. It is rather indicated that the average lifespan of refugees' camps is estimated at 17 years (Abu Al-Sha'r, 2017; Van der Helm et al., 2017). Yet, still up to date, the water is supplied using trucks to the camp. An average between 300 and 360 trucks transport water to the camp reaching 15.1 million litres daily (Abu Al-Sha'r, 2017; Al-Makhadhi, 2013; Ledwith, 2014; Farishta, 2014) to guarantee only as little as 35 L/p/d (Aburamadan et al., 2020; Ledwith, 2014) compared to 900 L per capital averages in the US (Ledwith, 2014). It is worth to state that since the opening of the Zaatari camp, it was only the Agency for Technical Cooperation and Development (ACTED) and the United Nations Children's Fund (UNICEF) who joined forces to mainly supply water to the Zaatari camp (Al-Makhadhi, 2013; Ledwith, 2014; Namrouqa 2014). Furthermore, Alshoubaki (2017) indicates that there is a huge increase in the water shortages following the Syrian's migration to the country (Fig. 1). Rural and urban areas are now witnessing two times water cut in a single month and by 33–44% less water of usual supply. Jordan is the country most affected by the Syrian refugees; more than 70% of the total Syrian refugees are hosted by Jordan and are increasing the demand of water supply by 62% of the total water vulnerability index (Alshoubaki, 2017). In turn, the increased water demand in the country resulted in the decline of the level of aquifers specially after the acute drop of renewable water in the country since 1967 at 1857 m^3/capital/year to 145 m^3/capital/year in 2013 (Al-Harahsheh et al., 2020; Schoeffler et al., 2012).

However, due to the fact that Al Zaatari refugee camp was built on the Amman-Zarqa Basin where the majority of the Jordanian's groundwater aquifer system and wells are located (Al-Harahsheh et al., 2020). The tension and fairs have started escalating about the condition and the quality of groundwater, especially in a country like Jordan which is recognised as the fourth poorest country in the world in terms of water resources (Abu Al-Sha'r, 2017; Alshoubaki, 2017). This is mainly caused by the communal WASH blocks comprising toilets blocks, showers and laundries, and multipurpose water points and sinks at an estimation use of 50 persons per communal toilet (Aburamadan et al., 2020; Alshirah et al., 2020; Van der Helm et al., 2017). In addition to the lack of drainage in a camp as huge as the Zaatari which results in areas swamped with run-off surface or prevent the harvesting of gray water (Millican et al., 2019). There is also an average of another 200 vacuum trucks that collect daily the wastewater in cesspits or block of latrines due to the lack of no existing waste infrastructure or sewage system in the camp (Abu Al-Sha'r, 2017; Melloni et al., 2016). Moreover, this massive transportation has initially caused the damage and degradation of the surrounding areas' road where complaints from the neighbourhood were registered to the local authorities (Abu Al-Sha'r, 2017).

However, there are some research that denies the abuse of water consumption from as many as 6000,000 Syrian refugees in the Zaatari camp. For instance, Farishta (2014) claims that the water consumed in the country is less than the existing supply amount. The country is using its resources sustainably. Farishta (2014) indicates that only 2.3% of the total water consumption in Jordan is being used by all the Syrian refugees in the country. Even in the worst-case scenario where the number of refugees reaches 1.2 million as projected, still that number affects the total water consumption only by an additional 2.2% (Farishta, 2014). Regarding the water shortage crisis in the country, Farishta (2014) explains that this issue has been long before the arrival of the Syrian refugees in the country. The Amman-Zarqa Basin was already experiencing overdraft

Fig. 1 Truck delivering water at Zaatari camp. From the ministry of water and irrigation, Jordan through Fanak-Water (2018)

extraction of 8.6 MCM since 2009 (Farishta, 2014). The unsustainable water management in the country resulted in the over pumping in the last few decades (Farishta, 2014).

Hence, Al-Harahsheh et al. (2015) have conducted research about the analysis of chemical and biological composition from different water samples collected from the Zaatari camp site and the surrounding areas. The results of chemical oxygen demand (COD) in the camp shows that there is pollution in the surface water. This is due to the chemical organic substance which is undegradable by the bacteria. Regarding the biochemical oxygen demand (BOD) in the camp, results show a high amount of BOD due to the swampy water that is mixed with sewage (Al-Harahsheh et al., 2015). Additionally, the results also show that the microorganisms in drinking water available in the camp are considered as very dangerous due to the pollution in the surface water. However, the deep aquifers and groundwater are faraway to be exposed to the pollution. But, because of the high permeability of the existing rocks in the area, there is a high risk that these resources can be affected (Al-Harahsheh et al., 2015). It is therefore obvious based on Al-Harahsheh et al. (2015) results that the Zaatari camp is considered as a source of pollution to the environment, groundwater, and its refugees themselves.

Furthermore, a recent study by Al-Harahsheh et al. (2020) also conducted to identify the quality and conditions of the groundwater in the Zaatari refugee's camp and surrounding areas. More than 30 wells were sampled from the area in order to determine and analyse the results against the water quality before the establishment of the camp. Results show the average value in pH of 7.2, where the majority of the water quality in the Zaatari camp comply with the standards drinkable water data in Jordan and indicate no threats of pollution (Al-Harahsheh et al., 2020). However, the refugee's camp will eventually impact the quality of groundwater and aquifers due to the evidence of deterioration on the quality of water compared to the 2012 data before the establishment of the camp (Al-Harahsheh et al., 2020).

2.2 Waste

Another impact of the Zaatari refugee's camp is its waste. The camp regenerates two different types of waste: wastewater and solid waste.

2.2.1 Wastewater

Given the fact that these refugees are dissatisfied with their shelter, inhabitants have chosen to handle their own business (Abu Al-Sha'r, 2017). It has been recently reported by Aburamadan et al. (2020) that 84.6% of the refugees' households has already installed their own bathrooms within their shelters as early as 2014. Even worse, Ledwith (2014) indicates that the refugees have a limited access to the materials and have taken the needed components from the public toilets to build their own facilities. However, the skills and performance required to such adjustments are inadequate amongst the refugees (Abu Al-Sha'r, 2017) which resulted in an increase of the black and gray water (Ledwith, 2014) as these toilets cannot be fitted with sewage, and the refugees are unfamiliar with the provided shelters models (Boen & Jigyasu, 2005). Figure 3 shows the sewage situation in the camp. Van der Helm et al. (2017) further indicates that 93% of the refugee's households' toilets are unregulated

and not sustainably connected. Regardless, 2.7 million litres of wastewater have been evacuated from the camp daily (Ledwith, 2014). Figure 2a demonstrates the disposition of the private toilets in the Zaatari camp as well as the outcome of the lack of sewage of those toilets Fig. 2b.

2.2.2 Solid waste

Another aspect of pollution is solid state where the Zaatari camp has an estimate of 680 large stores, and more than 120,000 refugees with 200 monthly children born (Ledwith, 2014). Thousands of tonnes of solid waste are generated from these population from different categories (Saidan et al., 2017) such as:

- Plastic mainly coming from packaging goods and carrying bags from the local shop in the camp,
- Organic, half million of pitas bread are distributed to the refugees in the Zaatari camp (Al-Makhadhi, 2013) on top from the household's waste,
- Paper cardboards are also generated from the existing local shops in the camp and from households' waste, newspapers, newsprint,
- Glass, all sort of glass from bottles, windows,
- Leather, wood, metal and textile are mainly from the construction of the refugees during their construction of facilities,
- Aluminium, from electronic devices, vehicle's batteries, computers and wires.

There was an attempt to construct a recycling point with the aid of refugees and humanitarian agencies to reuse such resources such as plastic and cardboard, but soon this was cancelled due to the lack of funds (Saidan et al., 2017).

As a result, the camp has become disastrous; each glass, cardboard, and plastic were found everywhere in the camp. Most of these materials have an estimation of life span between 5 and 450 years. This long process of non-biodegradability of those materials will add to the pollution of the environment dramatically.

2.3 Electricity

Jordan has not the water-shortage crisis in the country only; it imports up to 97% of its energy requirement from neighbouring Middle Eastern countries, where 96% of its electricity comes from fossil fuel (Alshoubaki, 2017). In addition, the increase of demand on electricity has risen by 1634 gigawatts only in five years starting from 2009. That has resulted in more consumption of petroleum gas by 336,000 tonnes in the same period (Alshoubaki, 2017). This is caused by the huge population coming to the refugees in Jordan that raised the consumption of electricity. For instance, to ensure safety in the Zaatari refugee's camp during the night, streets have to be lit. However, inhabitants in the camp started to illegally connect to those sources to aliment their shelters with electricity (Alshoubaki, 2017). It has been reported by Ledwith (2014) that more than 300 km of illegal electrical wires were connected to the public grid, Fig. 3a, b, representing 70% of the total residents in the camp (Alshoubaki, 2017). This has caused a resinous hazardous danger to the residents and to the humanitarians' organisations active in the camp. This huge distance only of electrical wires spread over a 530 hectares area has a negative impact on the environment (Ledwith, 2014).

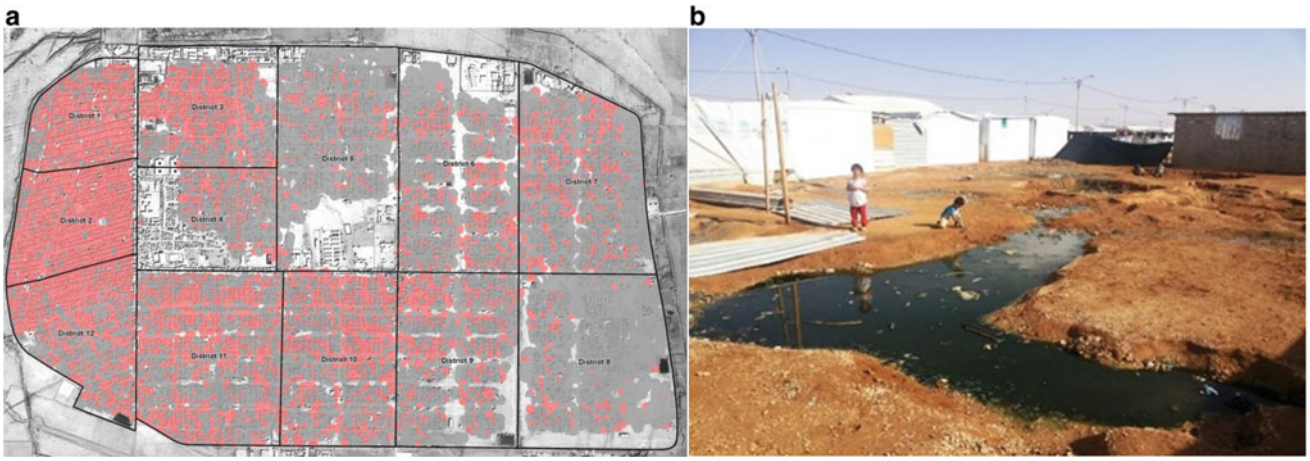

Fig. 2 **a** Unregulated toilets in the Zaatari camp. Der From Van der Helm et al. (2017, p. 523). **b** Children playing next to an open sewage pit in Zaatari. From Acted (2017)

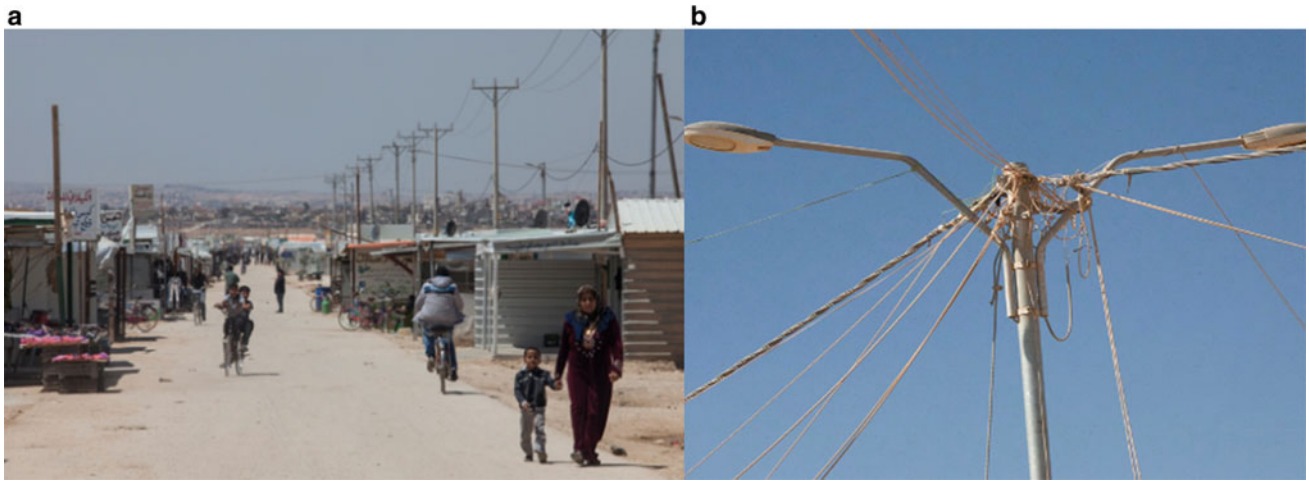

Fig. 3 **a** Electricity wires in Zaatari camp UNHCR (2017). **b** Illegal wireless connection. From Ledwith (2014, p. 33)

2.4 Air Pollution and Soil

It can be argued that the pressure on the road and transport system since the arrival of Syrian refugees has augmented. Thus, air pollution has certainly increased due to the different vehicle gas emissions (Alshoubaki, 2017). In addition, more than 500 water and vacuum tracks daily surrounding the area and the Zaatari refugees camp have also impacted the condition of the road due to the heavy weight of this last (Ledwith, 2004). However, research results of Al-Alshirah (2020) show that the amount of a slightly high concentration of heavy metals on the soil of the Zaatari camp. But, this does not consist of major pollution in the air or soil quality of the camp, instead it reflects the camp activities, and mobility of these low metals is inevitable. The only issue is that would increase the alkaline soil climate of the rock constitution in the Zaatari camp (Alshirah et al., 2020).

2.5 Medical Waste

The Syrian refugees often come in dramatic health conditions due to the civil war in their country. Since their presence in Jordan, pressure on the healthcare sector and emergency state occurred in the country. Similarly, Alshoubaki (2017) indicates that the medical waste is simultaneously augmented by 213,283 tonnes per year and 1127 m^3 equivalent of pharmaceutical waste per year. It is well known that Jordan has a lack and no adequate system that collects, treats and recycles or disposes of any sort of waste sector (AlDayyat et al., 2021). Thus, landfill capacity was exhausted, and disposal materials were found in the Zaatari refugees camp and surrounding areas which caused a deep environmental disaster (Alshoubaki, 2017). This will help the spread of the different diseases in the camp and will add to the pressure on the care sector of the country if even not the appearance of new viruses,

2.6 Social

Even though both the Syrian refugees and the Jordanian Indigenous share the same religion, language and ethnicity. This was not good enough to secure proper social cohesion between the two populations (Alshoubaki, 2017). Due to the fact that there are still many tribal identity variations amongst the two populations, tension has escalated, and conflict occurs especially in terms of use of public facilities and natural resources (Alshoubaki, 2017). Every part of the population wants to be recognised in its own way, if not become the leader. Whereas, it should be a mutual benefit between the two parties by taking into consideration the local conditions.

3 Sustainable Solutions and Development

The Zaatari Syrian refugee's camp has lasted nearly a decade since its establishment. Many researchers (Abu Al-Sha'r, 2017; Aburamadan et al., 2020; Dalal, 2020) indicate that the average lifespan of a refugee camp is 17 years. Therefore, the consideration of its design should meet the requirements during the period. However, in the case of Zaatari, there is evidence showing the negative impact of its poor design is the primary cause of the pollution (Abu Al-Sha'r, 2017; Aburamadan et al., 2020). Every component in the Zaatari's shelters is prefabricated and shipped to the camp (Abu Al-Sha'r, 2017) which justify the modifications of the inhabitants of their shelters that do not comply with what they were used to before the emergency (Aburamadan

et al., 2020). The refugee's expression on the poor design of special and architecture of their camp was translated through the modification accrued in the camp. In addition, the design and mass production of such shelters has been made in a different country. These countries have no adequate knowledge on the context's culture nor the climate condition. The shelters were then imported without compromising with the existing conditions which make the recovery process of the refugees more difficult (Barakat, 2003). The Zaatari refugee's camp has been recognised as not a sustainable camp and causing pollution to the surrounding area as well as harming its inhabitants in terms of the quality of its water supply, wastewater treatment and solid waste management system (Alshirah et al., 2020).

Abu Al-Sha'r (2017) further indicates that such temporary shelters are not cost-effective solutions; disregarding their lack of adaptability in the context, they also require a long-distance shipment that will add to the cost of their implementation and waste funds that may be invested in the construction of permanent housing. Due to the lack of funding for a proper construction of sustainable and permanent refugees camp, this has resulted to acquire a cheap and prefabricated shelters. In turn, these camps made out of prefabricated shelters will be used for an extended period one of time from the designed and require half million USD daily to be run and maintain them (Abu Al-Sha'r, 2017; Ledwith, 2014). Thus, the transaction from the emergency use to the sustainable phase for a better urban development and preservation of natural resources will improve the potential health conditions, environmental and financial risks (Van der Helm et al., 2017) and additionally contribute to the local architectural context when implementing local construction materials and effectively adapt to the local climate condition too (Abu Al-Sha'r, 2017).

Indeed, humanitarian organisations and different NGOs have attempted to ameliorate the current situation of the camp through the FARE Studio Summarisation project (Abu Al-Sha'r, 2017). This project was an update of the refugee's shelters to the local climate conditions specially the Jordanian summer. The privacy and improvement of thermal comfort were the primary concerns of this project (Abu Al-Sha'r, 2017). The FARE project intended to meet the sustainability development requirement, which means preserving the resources for the present and future generations (Purvis et al., 2018). Jordan has an arid climate condition with more than 6 months of summer and high potential of solar radiation (Gijsbertsen et al., 2017). Therefore, the implementation of solar panels to the refugees' shelters was a cost-effective solution (Abu Al-Sha'r, 2017). The FARE project also updated the door of the refugees' shelters and provided them with the flexibility of choosing their placement for more privacy.

However, the FARE project occurred a couple of years after the settlement of the camp, whereas it should be implemented during the design, planning, construction and implementation of the project. In turn, building a camp using the local materials is not only a cost-effective solution by cutting down the fabrication, transportation and installation of the shelters. But, it would be rather an environmentally friendly and outstanding thermal comfort construction for the inhabitant too that has a significant low carbon footprint and at the same time perfectly integrated with the local environment and climate conditions.

3.1 Waste Recycling

Abu Al-Sha'r (2017) supports the idea that the Zaatari refugee's camp can be self-government if it effectively implements sustainable solutions and exquisite potential opportunities. One of these opportunities is the exploitation of the recycling of the huge quantity of the Zaatari's solid waste. A recent study conducted by AlDayyat et al. (2021) on the potential of pyrolyzing the Zaatari's solid waste to bio-oil that will be used as an alternative source of energy. The thermal conversion process of multiple solid waste (MSW) using Fourier transform infrared spectroscopy (FTIR) for energy recovery is the ultimate multi-layers beneficiary solution (AlDayyat et al., 2021). For that reason, AlDayyat et al. (2021) took a sample form the Zaatari's MSW, and the analysis results shows that the potential bio-oil produced will consist of 55% of carbon, 37% of O_2 and a 20.8 MJ/Kg of higher heat value (HHV).

It can be concluded from Table 1 that 52.7% of the Zaatari's MSW comes from organic category coming from 59 municipalities (Saidan et al., 2017). Al-Addous et al. (2019) report that there is a saturation of landfill capacity due to the huge amount of waste production mainly coming from the Zaatari's refugees camp on a daily basis. The plan (2016) quantifies the weight coming from the Zaatari's solid waste at 1689 tonnes per day where more than 55% of it consists of organic waste (Al-Addous et al., 2019). This has a great impact on the environmental, economic and social aspect of the country and the surrounding areas (Al-Addous et al., 2019; Saidan et al., 2017).

However, the pyrolysis process does not produce the bio-oil only; it rather produces biochar indeed. Biochar is recognised as a soil amendment worldwide. And the analysis results from the FTIR shows the content consists of 47% of carbon, 49% of O_2 and 11.5 MJ/Kg of HHV (AlDayyat et al., 2021). AlDayyat et al. (2021) calculate a potential amount of 38 Nm^3/day of methane out of 21–65 m^3 of MSW to produce as much as 4 MW. The 1689 tonnes of MSW daily that contains such amount of carbon, oxygen, and high-heat value as indicated above for an alternative

Table 1 Average percentage composition of MSW at Zaatari camp in 2015

Waste categories (%)	High populated districts	Low populated districts	Commercial area	Zaatari (Average)	Average MSW in municipalities
Organics	55.84	52.60	49.65	52.70	59
Paper and cardboard	5.60	3.74	17.67	9.00	14
Plastics	11.39	13.23	13.91	12.85	10
Leather, wood, textile and rubber	11.57	13.99	5.10	10.22	10
Metal	3.69	3.70	7.08	4.82	5
Aluminium	0.27	0.32	0.65	0.41	
Glass	0.90	0.81	2.04	1.25	4
Inert material	0.04	0.37	0.23	0.22	5
Special Waste (Hazardous, etc.)	0.17	0.45	0.20	0.28	6
Miscellaneous–Bread	0.35	0.41	3.9	1.28	
Miscellaneous–Nappies	10.18	10.38	0.38	6.97	
Total	100.00	100.00	100.00	100.00	

From Saidan et al. (2017, p. 62)

Table 2 Estimated budget required for the Zaatari camp 2014–2018 in USD

Environmental factor	2014	2015	2016	2017	2018
Ecosystem preservation	N/A	7,300,000	1,650,000	1,800,000	300,000
Waste and sanitation	158,793,612	87,390,000	238,800,000	263,520,000	246,560,000
Energy	N/A	134,006,100	107,400,000	111,075,000	87,000,000

source of energy that can be replaced the fuel used in the camp or in the surrounding areas, to improve the quality of life and mitigate the environmental impact of fossil fuels is an innovative idea (AlDayyat et al., 2021).

Moreover, such exploitation will also reduce the amount spent daily on the camp for running its different facilities. The solar electric panel equipped in the refugees' shelters during the FARE project has dramatically reduced the amount of energy budget by nearly one third, from 111 million USD to 87 million USD during 2017 and 2018, respectively, as indicated in Table 2. In addition, the massive quantity of the biochar will be used for the gardening and will be beneficiary to the refugees and surrounding areas as an alimentation source and agriculture exploitation (Gijsbertsen et al., 2017). As such, the impact of instant cities on both the local environment and the host country will be dramatically reduced if such a kind of bio-oil and biochar solution is explored.

3.2 Gardening

The forced migrants from the civil war in Syria have reallocated to seek better life opportunities and services such as food, shelter, health care, mental health and well-being (Aburamadan et al., 2020). Thus, Millican et al. (2019) stress the importance and benefits of outdoors interaction with greenspaces, as well as physical activities. If combined with the consumption of fruits and vegetables, the potential of mental health and well-being in terms of horticulture-based interventions in urban areas will improve (Leake et al., 2009; Millican et al., 2019). Millican et al. (2019) indicate that often refugee's camps' inhabitants suffer from highly traumatised populations as they have just lost their houses and left their country. However, they are reallocated in a place with a very high density of population too, as they all share the same situation, which causes health, environmental and social risks. The benefit of the study results of AlDayyat et al. (2021) can be implemented to generate biochar and used as soil amelioration gardening in the Zaatari camp in order to ameliorate the environmental conditions of the camp, rather than desertic bleak place. The recovery of resources and reuse of it to contribute to psycho-social well-being on the refugees, and/or source of alimentation/income, has a massive positive impact on the whole system (Millican et al., 2019). In addition to the severe climate conditions of the country, greenspaces have a great potential of reducing the urban temperature dramatical and provide share and fresh air (Millican et al., 2019). It is also worthwhile to state that communal activities and gathering will create a relationship amongst the inhabitants and result in a personal peace and well-being (Fig. 4). Gardening

Fig. 4 Family planting outside their trailer at the Zaatari refugee camp in Jordan. From Rudoren (2015)

will also provide a sense of possession and belonging of the camp, which in turn creates a place that would be called home and shared community (Millican et al., 2019).

3.3 Water Management

Gijsbertsen et al. (2017) support the idea of implementing green spaces and agriculture in the Zaatari refugee camp and anticipate that it will bring a positive impact to the inhabitants of the Zaatari refugees and help the recovery process speed up. However, Gijsbertsen et al. (2017) indicate additional potentials of upgrading the Zaatari camp to sustainable and green by exploiting the rainfall that usually left overflowed during the 6 months of rain in the country. Also, this causes a risk of flooding due to the lack of sewage and drainage in the camp that may be a danger to the inhabitants' lives. The exploitation of rainfall in a country that suffers from water scarcity is an inevitable opportunity to seize, whether to supply the refugees with drinkable water or use for agriculture and gardening, it is highly beneficial in both ways (Gijsbertsen et al., 2017). Hence, Gijsbertsen et al. (2017) provide sustainable harvesting techniques to collect the waste rainwater unattended for use and also mitigating the rainwater flow on the surface in order to protect the soil erosion too. In regard to the wastewater and gray water, Gijsbertsen et al. (2017) suggest the implementation of a helophyte filter where the process is treated by bacteria living in the roots. Take for instance the case of Uganda that has hosted refugees back to 1958 from Democratic Republic of Congo. The integration of the refugees to the society, environment and contribution to the local economy in the case of Uganda is one of the most durable models ever seen (Fall, 2009). The refugees at Uganda have stayed more than six decades, and the local authorities have provided them with lands, seeds and necessary tools to work in the resource poor of the host country specially agriculture (Millican et al., 2019). By creating low-density refugee camps in Uganda, the local environment and population have received less pollution and impact. Instead, both parties have a common shared beneficiary (Millican et al., 2019). Uganda has created sustainable self-governance refugees implemented within sustainable solutions, rather than just responding to one–off crises (Millican et al., 2019). Sadly, and after all these years, the Zaatari refugee's camp could not learn from the extraordinary experience of Uganda in dealing with their sustainable green camp implementation. Regardless of the availability of the natural resources such as the sun and local construction building materials that would make the camp more efficient, not to mention the novel and modern techniques for building a well-established and sustainable green camp such as solar panels and waste recycling centres.

4 Conclusion and Recommendation

This study concludes that Zaatari refugee's camp is intentionally a cause for pollution for the region and its surrounding. As well as it still needs basic requirements such as wastewater drainage and sewages, electrical grid, roads and

sidewalks, freshwater system, and many more. Therefore, it is extremely important when it comes to building such instant cities is to take into consideration the local building materials to adapt to the local climate and cut the cost of fabrication and transportation of the shelters. Not with standing the importance and relevance of the implementation of sustainable, durable, and natural resources technology in such instant cities.

It is clear both visibly and through this study that the camp had already impacted the surrounding environment on so many levels. Part of it is due to the natural urbanisation process and the negative impacts that occur with it such as gray water, solid waste, and so on. On the other hand, the treatment and operational philosophy of the camp is causing more harm due to the "temporary notion" which prevents them from dealing with the environmental consequences. Although the authorities are initiating some management tactics for sustainable approaches like solar cells and some water treatment methods, a clear and focussed approach must be set, in order to ensure that the camp will not reduce the environmental balance in the area, on both short and long terms. The self-government of the Zaatari refugee's camp and existing potential for sustainable development seems to extend to an extent where the term "temporary" has changed, and therefore, local authorities and stakeholders' management of the camp has to change too (Abu Al-Sha's, 2017).

This research would like to highlight again the importance of dealing with the issue with the urgency and long-term impact that it has. Hence, this research recommends the initial establishment strategies for short and long-term plans to deal with the crisis for the purpose of enhancing and maintaining the environmental character of the area. The local authorities in the camp need to have a condition assessment to ensure dealing with pressing issues environmentally. Secondly, conducting environmental awareness programmes for the refugees to encourage them to enhance the environment quality of the camp. Finally, researchers must obtain their role in documenting the past, current and forecasted situation in order to highlight the situation and need for action. Chances of implementing and integrating sustainable solutions to better improve the quality of life and comfort of the residents never been too late. However, these solutions would be more efficient if they were implemented as early as the planning stage (Millican et al., 2019). The Zaatari refugee's camp still needs basic requirements such as wastewater drainage and sewages, electrical grid, roads and sidewalks, freshwater system, and many more. Yet, the most important strategy that the Zaatari refugees camp lacks is the awareness of the inhabitants to wisely use resources and facilities, especially in a country such as Jordan that lacks many natural resources and are in a serious decline (Al-Harahsheh, 2015). Also, the low-density refugee camp is more effective and less harmful to the environment than large-scale refugees that need to be taken into consideration in the planning stage for the next implementation of such a crisis.

References

Abu Al-Sha'r, R. (2017). *Rethinking shelter design: Zaatari refugee camp* (Doctoral dissertation).

Aburamadan, R., Trillo, C., & Makore, B. C. N. (2020). Designing refugees' camps: Temporary emergency solutions, or contemporary paradigms of incomplete urban citizenship? Insights from Al Za'atari. *City, Territory and Architecture, 7*(1), 1–12.

Acted. (2017). *Another step towards Zaatari's wastewater network!* Retrieved from ACTED: https://www.acted.org/en/another-step-towards-zaatari%E2%80%99s-wastewater-network/

Al-Addous, M., Saidan, M. N., Bdour, M., & Alnaief, M. (2019). Evaluation of biogas production from the co-digestion of municipal food waste and wastewater sludge at refugee camps using an automated methane potential test system. *Energies, 12*(1), 32.

Al-Harahsheh, S., Al-Adamat, R., & Abdullah, S. (2015). The Impact of Za'atari Refugee camp on the water quality in Amman-Zarqa Basin. *Journal of Environmental Protection, 6*(01), 16.

Al-Harahsheh, S., Al-Taani, A. A., Al-Amoush, H., Shdeifat, A., Al-Mashagbah, A., Al-Raggad, M., Al-Omoush, R., Al-Kazalah, H., Hraishat, M., Bani-Khalaf, R., & Almasaeid, K. (2020). Assessing the impact of Zaatari Syrian Refugee Campin Central North Jordan on the Groundwater Quality.

Al-Makhadhi, S. (2013). Syria Refugees Settle in Zaatari with the help of a de-facto German mayor. In *The National*.

Al-Rai. (2012, July 30). افتتاح مخيم الزعتري لإيواء اللاجئين السوريين. Alrai. Retrieved September 29, 2021, from http://alrai.com/article/530134.html

AlDayyat, E. A., Saidan, M. N., Al-Hamamre, Z., Al-Addous, M., & Alkasrawi, M. (2021). Pyrolysis of solid waste for bio-oil and char production in refugees' camp: A case study. *Energies, 14*(13), 3861.

Alshirah, M. H., Jiries, A., & Shatnawi, A. (2020). Impact of Syrian refugee camp on water, air and soil quality at Zaatari refugee camp/Jordan. *International Journal of Hydrology, 4*(2), 76–82. https://doi.org/10.15406/ijh.2020.04.00229

Alshoubaki, W. E. (2017). *The impact of Syrian refugees on Jordan: A framework for analysis* [Doctoral dissertation]. Tennessee State University.

Barakat, S. (2003). Housing reconstruction after conflict and disaster. *Humanitarian Policy Group, Network Papers, 43*, 1–40.

Bayat, A. (1997). Un-civil society: The politics of the 'informal people.' *Third World Quarterly, 18*(1), 53–72.

Betts, A., Loescher, G., & Milner, J. (2013). *The United Nations High Commissioner for Refugees (UNHCR): The politics and practice of refugee protection.* Routledge.

Boen, T., & Jigyasu, R. (2005, December). Cultural considerations for post disaster reconstruction post-tsunami challenges. In *UNDP Conference*. http://www.adpc.net/IRC06/2005/4-6/TBindo1.pdf

Cohen, R. (1991). *Human rights protection for internally displaced persons*. Refugee Policy Group.

Dalal, A. (2014). *Camp cities between planning and practice: Mapping the urbanisation of Zaatari camp*. Stuttgart University & Ain Shams University.

Dalal, A. (2020). The refugee camp as urban housing. *Housing Studies*, 1–23. https://doi.org/10.1080/02673037.2020.1782850

El-Hinnawi, E. (1985). Environmental refugees.

FALL, A.B. (2009). Towards a more formal approach on refugee gardening with UNHCR. Urban Agriculture Magazine 21:18

Fanak-Water. (2018, September 11). Jordan's scarce water reserves under pressure from refugee influx. Retrieved from Fanak Water: https://water.fanack.com/jordans-scarce-water-reserves-under-pressure-from-refugee-influx/

Farishta, A. (2014). *The impact of Syrian refugees on Jordan's water resources and water management planning* (Doctoral dissertation, Columbia University).

Gijsbertsen, C., Kuiper, M., Borst, L., van der Horst, I., & van Veldhuizen, H. (2017). Water management and irrigation near Za'atari Refugee Camp–Jordan. SamSam Water, VNG International and City of Amsterdam.

Khandaji, H., & Makawi, M. (2013). 54,000 Syrians bribe their way to Escape Zaatari Camp. *Arab Reporters for Investigative Journalism*.

Leake, J. R., Adam-Bradford, A., & Rigby, J. E. (2009). Health benefits of 'grow your own' food in urban areas: Implications for contaminated land risk assessment and risk management? *Environmental Health, 8*(1), 1–6.

Ledwith, A. (2014). *Zaatari: The instant city*. Affordable Housing Institute.

McGregor, J. A. (1996). Climate change and involuntary migration: Implications for food security. *Climate Change and World Food Security*, 257–275. https://doi.org/10.1007/978-3-642-61086-8_10

Melloni, G. M., Parpaleix, L. A., & Pajak, J. (2016). Sanitation management and information technology in Za'atari refugee camp, Jordan.

Millican, J., Perkins, C., & Adam-Bradford, A. (2019). Gardening in displacement: The benefits of cultivating in crisis. *Journal of Refugee Studies, 32*(3), 351–371.

Namrouqa, H. (2014). *Jordan world's second water-poorest country* (p. 22). The Jordan Times.

Plan, J. J. R. (2018). The Jordan response plan for the Syria crisis 2018–2020.

Purvis, B., Mao, Y., & Robinson, D. (2018). Three pillars of sustainability: In search of conceptual origins. *Sustainability Science, 14*(3), 681–695. https://doi.org/10.1007/s11625-018-0627-5

Renaud, F. G., Dun, O., Warner, K., & Bogardi, J. (2011). A decision framework for environmentally induced migration. *International Migration, 49*, e5–e29.

Rudoren, J. (2015, September 22). Inside a Jordanian refugee camp: Reporter's Notebook. Retrieved from the New York Times: https://www.nytimes.com/2015/09/22/insider/inside-a-jordanian-refugee-camp-reporters-notebook.html

Saidan, M. N., Drais, A. A., & Al-Manaseer, E. (2017). Solid waste composition analysis and recycling evaluation: Zaatari Syrian Refugees Camp, Jordan. *Waste Management, 61*, 58–66.

Scheel, S., & Ratfisch, P. (2014). Refugee protection meets migration management: UNHCR as global police of populations. *Journal of Ethnic and Migration Studies, 40*(6), 924–941.

Schoeffler, N., Aljaradin, M., & Persson, K. M. (2012). Groundwater quality in the surroundings of Mafraq landfill, Jordan.

UNHCR. (2017). Jordan's Za'atari camp goes green with new solar plant. Retrieved from UNHCR: https://www.unhcr.org/news/latest/2017/11/5a0ab9854/jordans-zaatari-camp-green-new-solar-plant.html

Van der Helm, A. W., Bhai, A., Coloni, F., Koning, W. J. G., & De Bakker, P. T. (2017). Developing water and sanitation services in refugee settings from emergency to sustainability–the case of Zaatari Camp in Jordan. *Journal of Water, Sanitation and Hygiene for Development, 7*(3), 521–527.

Wilkinson, E., Schipper, L., Simonet, C., & Kubik, Z. (2016). *Climate change, migration and the 2030 agenda for sustainable development*. Swiss Agency for Development and Cooperation SC.