

Environmental health issue related to heavy metals of ger residents of Ulaanbaatar, Mongolia

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Background

Mongolia is located in East Asia and bordered by China and Russia, as illustrated in **Figure 1**. Ulaanbaatar is the capital city of Mongolia. Ulaanbaatar has nine districts including Sonigokhairkhan, Sukhbaatar, Bayangol, Khan-Uul, Bayanzurkh, Chingeltei, Nalaikh, Bagakhangai and Baganuur.

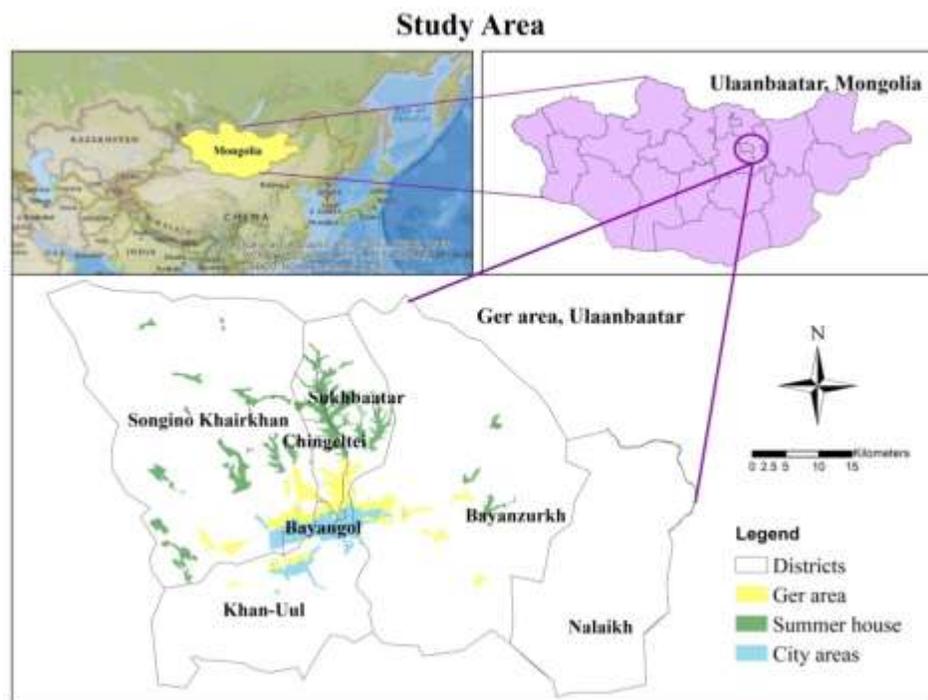


Figure 1. Research area, Ulaanbaatar, Mongolia.

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At present, Mongolia has 3.3 million people's lives, however, half a million people (population 1,615,094) live in Ulaanbaatar city due to migration from rural and capital city last two decades [1]. This trend would increase in the next decade in the future as showed the **Figure 2**. Due to unpredicted population growth in capital city over last a decade, the city has expanded in the capital city. The reason for migration is to improve their living condition, to study at university, and to find a job. There are 2 types of dwelling in Ulaanbaatar such as ger and apartment. Migrants usually settle in the Ger districts where the cheapest house than apartments in the Ulaanbaatar is. Around 60 percent of residents or 212008 household are living in ger districts in the city as showed the **Figure 3** [2].

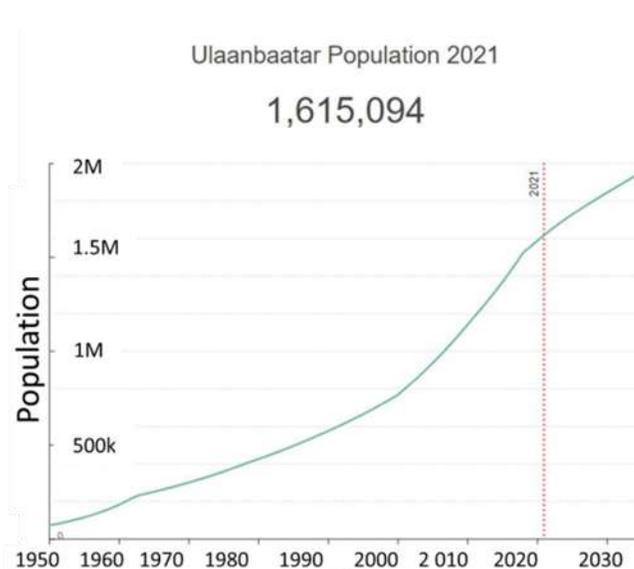


Figure 2. Number of population of Ulaanbaatar city.
Source: worldpopulationreview.com

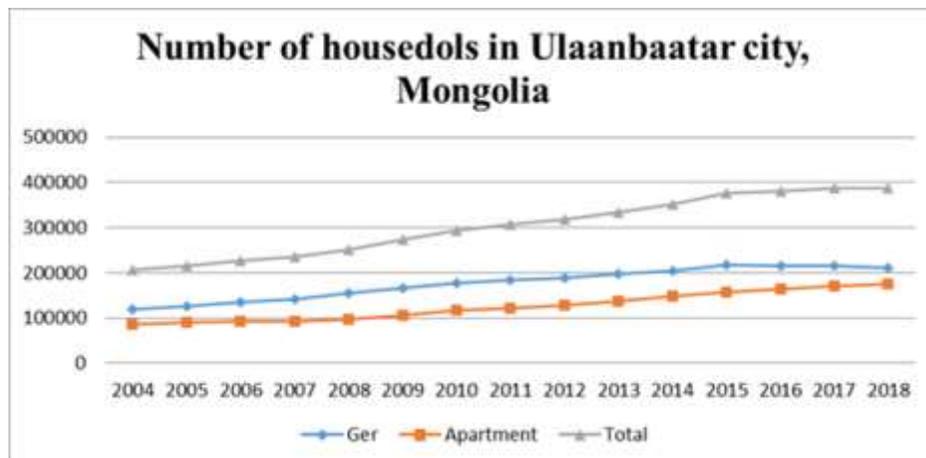


Figure 3. Number of population and households of Ger and apartment in Ulaanbaatar city. *Source: www.ubstat.mn/horoo*

As showed in **Figure 4** the Ger is Mongolian traditional round shaped dwelling. Ger consists of felt covers, wooden columns and round window at the top, thin wooden poles and floor, wall and ropes which is eco-friendly, easy to move, and adapted for the nomadic lifestyle in Mongolia where use the cattle feces, and wood for their heating and cooking in the countryside. Therefore, there is no waste from fuel to the environment.



Figure 4. Mongolian traditional ger house.
Source: <https://www.discovermongolia.mn/>

However, Ger house has been a critical pressure issue in the capital city due to unplanned expansion. Because of wide inequalities exist between the Ger area and apartment in terms of access to heat, water system, sanitation and waste, except electricity. Ger house is not suitable to the urban areas without any central basic infrastructure for the long term. This situation is created to the two types of settlements in the capital city as illustrated in the **Figure 5**. The average size of land plots for per ger household is occupy in 700 m² size, which individual households are entitled to by law. The capital city has expended 30 times larger now than the original built-up areas, especially by Ger districts. The Mongolian government has been developing strategy policy since 2013 such as Master Plans, including Ger districts which to better manage expansion of the ger areas. However, its improvements on urban services are slow. Therefore, the ger areas have been continuing to expanding until recent, and the local government's capacity to respond to these challenges is still limited [3].



Figure 5. Current condition of ger districts

Source: (a) <http://sedev.mn/15933.html>,

(c) <http://www.bolod.mn/News/81470.html>

Ger districts are connected only to central electricity, but they use the stove in wintertime for their heating and cooking due to harsh climate of Mongolia, the high tariff of electricity and low capacity of electricity. They must travel to public kiosks between 500m and 2 km from their homes to purchase water, which they carry back home in plastic or metal tanks. Moreover, Ger districts have mixed wastes such as coal ash and other combustible materials. The frequency of waste collection is lower than apartment and the collected waste are disposed to the main three dump sites without any classifications. The Figure 6 is shown the lack of current condition of infrastructure in capital city.

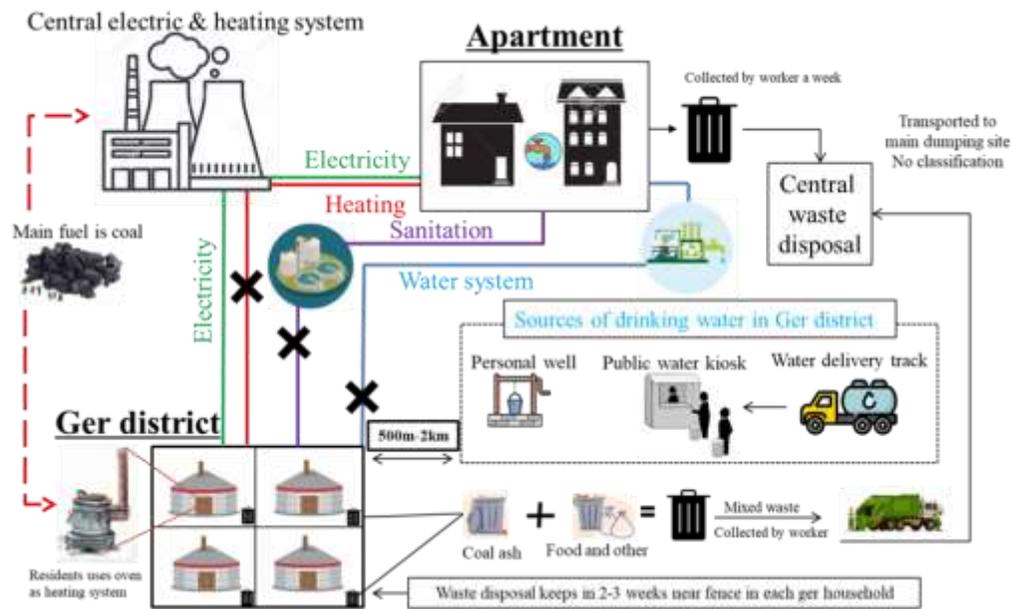


Figure 6. Lack of infrastructure in ger area of Ulaanbaatar city.

Statement of problems in Ger districts of Ulaanbaatar

There are many problems in ger districts for environmental human health issue due to lack of basic infrastructure such as waste management, water, sanitation, heating system, toilet and water sewage, except electricity. Therefore present research considered the as health and environmental risk related to heavy metals pollution in ger districts. The following issues will be considered in this doctoral dissertation.

Heating systems: Coal is the primary source of energy in Ulaanbaatar, Mongolia, and accounts for approximately 90% of the energy sector in Mongolia [4]. All of the ger residents were the consumer of coal mines of Baganuur and Nalaikh. They used to buy their raw coal from the individual coal retailers sellers in Ulaanbaatar, and also they used to buying grossly by themselves at both mines which were used in the whole wintertime.

On the other hand, the Mongolian government has banned raw coal since May 2019 due to air pollution of the capital city which is implementing under Government Resolution No. 62 of 2018 that has been decided not to import raw coal for domestic use in Ulaanbaatar. Currently, the ger residents are using briquette coal which is prepared at the coal mine of Tavan Tolgoi in Umnugovi, according to the cooperation with the Mongolian Government. The briquette coal has been transporting to distribute for markets of retailers

sellers (around 360 markets) in Ulaanbaatar from the coal mines of Tavan Tolgoi since 2019. However, there is still having pressure issue of air pollution and the waste issue of coal ash.

Solid Waste Management

A household of ger residents uses approximately 1.1–1.3 million tons of raw coal a year [5], which is imported from the coal mines of Baganuur and Nalaikh, because raw coal is a source of energy. As a result, around 198,000–230,000 tons of coal ash are generated and require disposal per year. Ger residents have produced the coal ash around 30.4 tons (189,535 households) per day which is transported to three main dumpsites without any classified and burning immediately using the landfill method [6]. Unfortunately, due to the lack of management for coal ash disposal in the ger area, most of residents are disposing of coal ash in illegal and unregulated points such as public waste points and ravines near the ger area. On the other hand, the coal ash waste was approximately 49% of waste disposed of in Ulaanbaatar in wintertime in 2013 [7].

Moreover, the coal ash and other wastes are collected from outside of hence each ger household around twice or the three times per month which is disposed to three main dumpsites such as at Naran's enger, Ulaan chuluut, and Morin's davaa without being classified and burning immediately using the landfill method. The solid waste management in the ger district of the capital city is facing a critical challenge that is one of the most pressing issues concerning public health and the environment [8]. The proceeding of current dispose of municipal waste of ger district in Ulaanbaatar is shown in **Figure 8**.

Waste management in ger district of Ulaanbaatar city is weak and there is no management for coal ash waste until today. Although the waste collection fee is inexpensive, but only 40% of households of ger district are paid their waste fee per month due to low income and poor life [9]. Moreover, truckers for waste collecting cannot go the road of the narrow way in some ger districts and cannot collect some the wastes [10]. The ger residents have been disposing of their coal ash in unregulated and illegal places such as ravines and near their fence. This is one of the main pollution of soil contamination by heavy metals in the Ger area of Ulaanbaatar city.

Moreover, when coal is burnt in the stove of a ger dwelling, a lot of ash is produced. A small part of coal ash is dispersed in the air (fly ash) and most will stay in the stove [11]. After the burning process is finished, the remaining ash is collected in a bucket, and mostly thrown into the open street on bare soil. Surprisingly, hot ashes can help reduce a slippery surface and provide cover in the open street in the winter period (November to March) [5]. This is the one of the main reason why coal ash and its heavy metals fly in the air as well as accumulate in the soil and dissolve in water.

On the other hand, there is one case of ingestion from waste dumps to human health. Because of the domestic cattle of neighbor nomads usually come to seek food from open dump areas, which may be one source of ingestion pathway [12]. If in the milk of these cattle and meat sales to consumers, it would be necessary to control the products from these cattle by the professional inspection agency of the urban city of Ulaanbaatar. There were many cows that died because their intestines were also clogged with plastic [13]. Human is consuming the plastics eaten by livestock through dairy products and meat. If not regulated, it could eventually become poisonous and erode the entire human race," the nomads warned. Not only is plastic eroding the human body through livestock, but it also leads to environmental destruction[14].

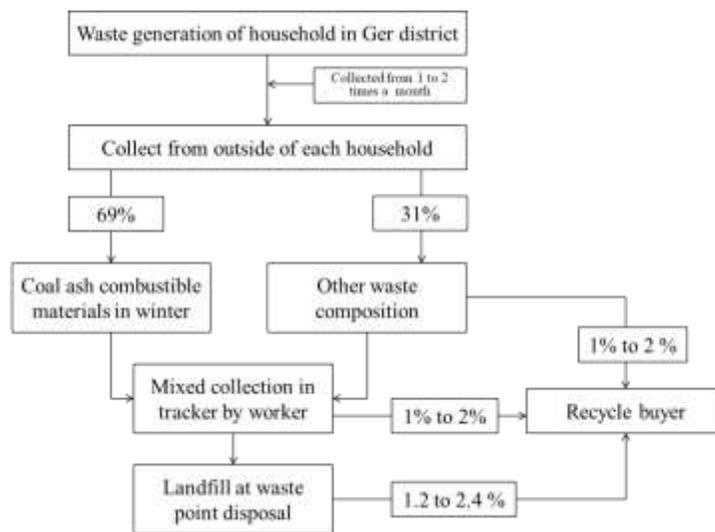


Figure 8. The proceeding of current dispose of municipal waste of ger district in Ulaanbaatar [8][10].

The **Figure 9** showed the current issue of main dumping site related to domestic cattle of neighbor nomads.



Figure 9. Current issue of main dumping site related to domestic cattle of neighbor nomads.[14]

Health issues: The lack of basic urban services in the ger areas has also resulted in environmental degradation, including the pollution of air, water and other natural resources. The estimated annual exposure of PM 2.5 (particulate matter) to urban residents was 10 times higher than Mongolia's national air quality standard and 6-7 times higher than the World Health Organization's permissible requirements [15]. This is an example of the fact that ger area ash has reached a level that poses a serious threat to public health. The main causes of PM 2.5 particles are incompletely burned coal and fine ash in the form of aerosols formed during combustion. As reported the UNICEF that which mentioned the short- and long-term exposure to fine particles is directly related to the risk of cardiovascular disease and hospitalization for pneumonia [16]. Nowadays, in Ulaanbaatar, diseases of the treatment regimen, digestive system, and cardiovascular system are the leading causes in rural areas in 2019 [17].

Numerous public health problems are caused by coal usage, especially coal ash. Motoyuki Nakao et al. [18] investigated the effects of air pollution and seasons on health-related issues in adults living in both Ger districts and apartments in Ulaanbaatar. They concluded that there was no significant difference in health-related quality of life between

both settlements in the warm season; however, health-related quality of life was worse for Ger residents than for apartment resident due to solid fuel combustion in winter by the Ger residents.

In addition, So et al. [19], analyzed the lifestyle and living environment factors in Ger districts influencing the health of residents. They observed that in self-reported surveys, residents cited symptoms such as eye irritation, heart-related disorders, nose and throat irritation, breathing difficulties or asthma, depression, and skin problems due to indoor air pollution had impacts on the health of residents. Previous studies above focused on the relationship between air pollution and public health. Conversely, soil contamination by coal ash could also have adverse effects on public health in the Ger areas.

According to [20], the incidence of respiratory infections was 38,699, which is the highest over the last five years (2016–2021). Approximately 120–130 children and 1,250 adults died of pneumonia last year, represent is an increase by 8,715 cases when compared to the number in 2015.

Less number of studies on human health based on daily behavior related to the living conditions in previous studies. Therefore, it necessary to study to more detail health issues and damage related to heavy metals in soil and water in ger residents .

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