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# AWARENESS ON AIR POLLUTION AND RISK PREPAREDNESS AMONG RESIDENTS IN KIGALI CITY OF RWANDA

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## *ABSTRACT*

The rapid human population growth, industrialization, urbanization, agricultural expansion and other development activities are gradually polluting the quality of air with severe effects on the human health and environment as well. This is particularly, exacerbated by lack information sharing which limits the risk assessment, and community approach to identify the key sources and the mitigation or adaptation strategies. The aim of this study was to assess the extent of air pollution risk awareness in order to enhance its preparedness and adaptation in Kigali City of Rwanda. The authors conducted an interview with 225 respondents randomly selected among the residents in May 2018. The results indicated that the primary air pollution sources are automobile highlighted by 45 percent of respondents, followed by stationery sources at 36 percent. However, the air pollution risk related information is mainly provided at television (50%), owned by 32 percent in contrast of radio possessed by 49% of residents, but used at low extent (36%). This consequently, leads to health problems, acid rain and natural resources depletion as stated by the informants. Accordingly, the air pollution risk awareness is at low level, as respondents highlighted that the related education/training is delivered at low extent (9.3 percent), despite its role in risk awareness and preparedness among the community. While the car free day (32.4%) and forestland expansion (42%) are practiced at large extent than education. The relevant community air pollution risk awareness and reduction measures are suggested.

**Contribution/Originality:** This study is one of very few studies which have investigated the awareness on air pollution and the degree of preparedness to the risk in Kigali city of Rwanda. Thus, its findings will help policy makers to better set up air pollution abatement measures under consideration of the residents' wellness.

## 1. INTRODUCTION

The air pollution is an environmental problem with gradual significant socio-economic and environmental threat due to the fact that, the risk awareness is not appropriately reaching the recipients (Cohen *et al*., 2005; Henschel *et al*., 2012). The rapid human population growth, industrialization and urbanization, inappropriate wastes treatment and sources of energy used, are reported (Nduwayezu *et al*., 2015; Vert *et al*., 2017; Bounoua *et al*., 2018) to pollute the air quality. This consequently, impacts on human health and causes respiratory infectious diseases such as the cough, influenza, headaches and asthma, and effects on the environment by causing global warming and climate change. Due to the severity of air pollution among people, some air pollution risk reduction measures such as cleaner transport, energy-efficient housing, better municipal waste management, reduction of household coal use and $CO_2$ sources, etc., are under execution (Egondi *et al*., 2013; Nduwayezu *et al*., 2015).

Nevertheless, as previously reported (Egondi *et al*., 2013; Khan and Kraemer, 2014; Kruza *et al*., 2017; Yoda *et al*., 2017) human population is continuously being exposed to the risk of air pollution, for example, in 2014; about 92 percent of the world population was living in places where the WHO guidelines on air quality standards were not well met. The reports also, showed that around 88% of the premature deaths were registered in low-middle-income countries, mainly in the Western Pacific and South-east Asia due to air pollution. The burden of air pollution is not similar in both developed and poor countries, within developing countries, the risk is reported to be primarily triggered lack of risk awareness, where local community's daily activities like cooking, agriculture, transport and waste management are practiced in way that leads to increasing the air polluters (Carter *et al*., 2012; Deguen *et al*., 2012).This is associated with the changing climate resulting on the increasing greenhouse gases emitted into the atmosphere and then pollute the air quality, with large effects on poor communities (Holm *et al*., 2013; Bhatta *et al*., 2016). This expresses that, community approach; early and appropriate information sharing would help to clarify the sources and extent of air pollution, and building a consensus on the priorities to be undertaken for the risk reduction.

In Rwanda, the air pollution primarily comes from the vehicular emissions, use of second hand vehicles, adulteration of fuel products, improper traffic management system, industrial pollution and other human activities (Nahayo *et al*., 2016). Although the level of air pollution in Rwanda is still low compared to other countries (Scheren *et al*., 2000; Nyangababo *et al*., 2005) Kigali City is exponentially reported (Etale and Drake, 2013; Rosa *et al*., 2014; Nduwayezu *et al*., 2015) to be polluted at large extent compared to other regions countrywide. The air pollution in Kigali city is primarily associated to high population exodus from other provinces, high rate of urbanization, unplanned housing and industrialization, vehicle density, predominance of old vehicles, and lack of regular pollution assessment and control (Henninger, 2013). This expresses the importance of approaching the residents of Kigali City whose daily activities are key drivers to the air pollution and likely impacted by the resulting risks as well. Hence, the objective of this study is to assess the extent of air pollution risk awareness and suggest relevant measures for the pollutants reduction, risk awareness and preparedness among the residents of Kigali city of Rwanda.

## 2. METHODS AND MATERIALS

### *2.1. Description of the Study Area*

The City of Kigali is the capital and largest city of Rwanda inhabited by 1.2 million people, with the total area of 370 $Km^2$. The City is geographically located at the heart of Rwanda Figure 1 in the middle of mountains of Eastern, Northern, and Southern Provinces, with a latitude of 1° 40'-2° 00'South and a longitude of 30° 00'-30° 40' East. The City of Kigali is more than 70 percent urban and is composed by 3 districts namely: Gasabo, Nyarugenge and Kicukiro divided into 35 Sectors, 161 Cells and 1,061 villages. Kigali city has a tropical climate with an average annual temperature of 20.1 °C. The warmest month is August with 20.7°C. The average rainfall is about 1000mm

per year. The lowest rainfall is recorded in July (8mm) while in April the rainfall is high (168mm) (Nduwayezu *et al.*, 2015).

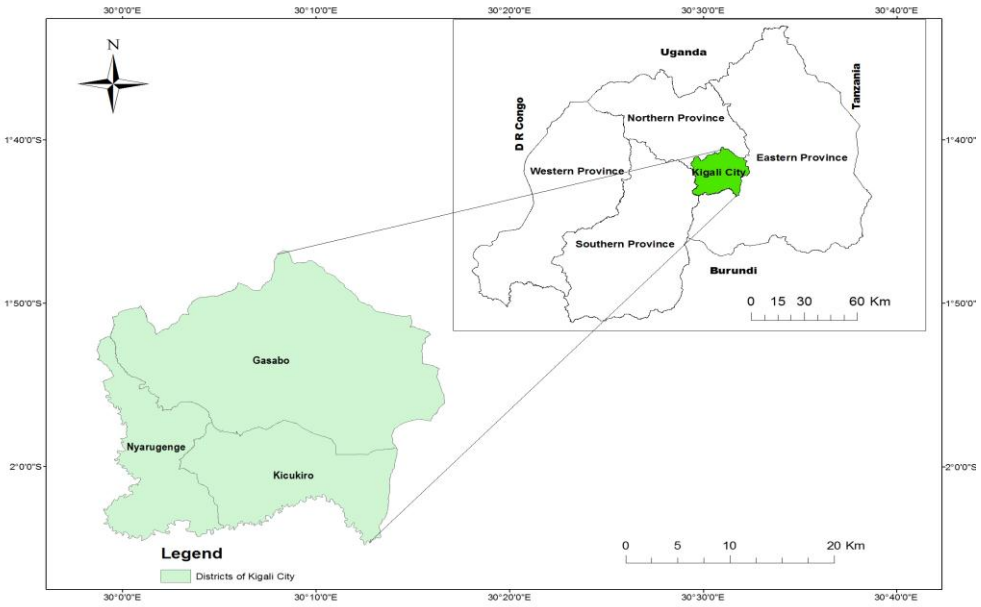


**Figure-1.** Location of Kigali city and its bordering provinces in Rwanda.

### *2.2. Data Collection and Analysis*

This study was conducted in May 2018 to assess the extent of air pollution risk awareness among the residents of Kigali city. The authors chose the case study due to the fact that, Kigali city is the large city in Rwanda with large number of human activities that likely cause the air pollution such as automobiles, industries, factories, international airplane, etc. compared to other regions in Rwanda (Etale and Drake, 2013; Rosa *et al.*, 2014; Nduwayezu *et al.*, 2016).The study population was selected from the residents and local leaders of the three districts of Kigali city. However, as the study area is inhabited by a large number of citizens, the authors randomly selected seventy five respondents within every district.

These respondents included ten (10) local leaders selected among others from district to cell level and sixty five (65) respondents selected among local residents of Kigali city. The detailed description of respondents by gender, age and education level is illustrated in the following Table 1 below.

**Table-1.** Distribution of respondents by Age, Gender and Education.

| **Age** | **20-30** | **31-40** | **41-50** | **51 and above** | | **Total** |
|---|---|---|---|---|---|---|
| Frequency | 98 | 67 | 42 | 18 | | 225 |
| Percentage | 43 | 30 | 19 | 8 | | 100 |
| Gender | Male | Female | | | | |
| Frequency | 99 | 126 | - | - | - | 225 |
| Percentage | 44 | 56 | - | - | - | 100 |
| Education | Primary | Secondary | Bachelor | Master | Ph.D. | |
| Frequency | 97 | 60 | 45 | 21 | 0 | 225 |
| Percentage | 43 | 26 | 20 | 10 | 0 | 100 |

As shown in the above Table 1, among total 225 respondents, 56 percent were female, 43 percent were aged between 20-30 years old and a large number of respondents attended primary schools (43%) at a high rate compared to other studying levels.

The authors obtained respondents 'answers through an interview. This was due to the fact that, the respondents were met at their respective houses and/or offices during daily activities, and this could not easily allow respondents to get sufficient time to fill in questionnaire and/or answer open-ended questions. In addition, the authors considered the fact, some respondents alone, could not easily read or understand the terms related to the questions, and then prepared a short interview with them, and for easy communication with respondents, the interview questions were translated into the local language (Kinyarwanda). The interviewees were provided alternatives and were asked to mention the ones fitting with the answers to the asked question(s).The authors prepared a set of close-ended questions to ask during a 5 to 15 minutes face-to- face interview. Moreover, the other reason of using a face-to-face interview was that, online interview could fail, since all respondents do not have access to the internet 24 hours.

To ensure that the objectives of the study were assessed, the following questions were addressed to the interviewees: First objective*: Reveal the main air pollutants in Kigali city*, and options like: (a) respondents' knowledge on the sources of air pollution such as industries, charcoal use, automobile, were provided to respondents then they picked the most relevant based on their knowledge. The second objective was to: *Assess the extent of air pollution risk awareness among the residents of Kigali city*, and questions on: (a) the primary tools used to share the air pollution risk information such as radio, television, local meetings and (c) the consequences of air pollution such as health effects, climate change and natural resources degradation, were asked to the residents. While the last objective was to *assess the measures initiated for the air pollution risk reduction and preparedness* and here, only the leaders were asked to rate the measures under execution among the listed and under execution in Rwanda mainly: (a) air pollution risk education/training, (b) car free day and (c) trees planting for the carbon dioxide absorbing. Furthermore, after the input data collection, the primary data were edited and coded into frequency and percentage for the results analysis done with the Microsoft Excel software.

## 3. RESULTS

The following section describes the results obtained from the interview conducted with 225 residents of Kigali city on the main sources of air pollution, their risk awareness and the tools used by local leaders to approach the community for the air pollution risk awareness, preparedness and reduction as well.

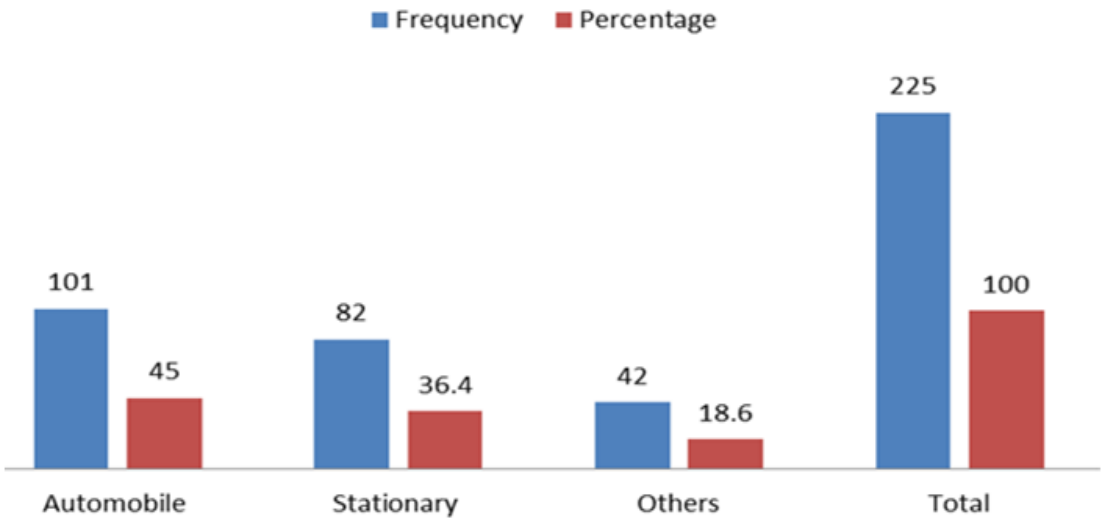


**Figure-2.** Air pollution sources in Kigali city.

The major air pollution sources in Kigali City, as highlighted by 45 percent of respondents, are automobile sources, such as cars, buses, trucks, planes, etc., followed by 36.4 percent who mentioned the stationary sources such as power plant, oil refineries, factories and industrial facilities, and other sources (18.6%) such as the agricultural

emission, wood burning and man-made fires. Although the residents mentioned the key air pollutants in Kigali city, the related risk reduction measures and/or preparedness information may not reach all the target people, due to the fact that, as illustrated in Figure 3, the tools used for the communication are not equally reached. The interview answers on the possession of communication channels provided by 195 residents and the communication rate highlighted by thirty (30) leaders revealed that the air pollution risk information is not easily reaching the residents, as it is largely communicated at televisions (50%), owned by a low percentage (32%) of respondents in contrast of the use of radio (36%), possessed by almost a half of the total respondents (49%).

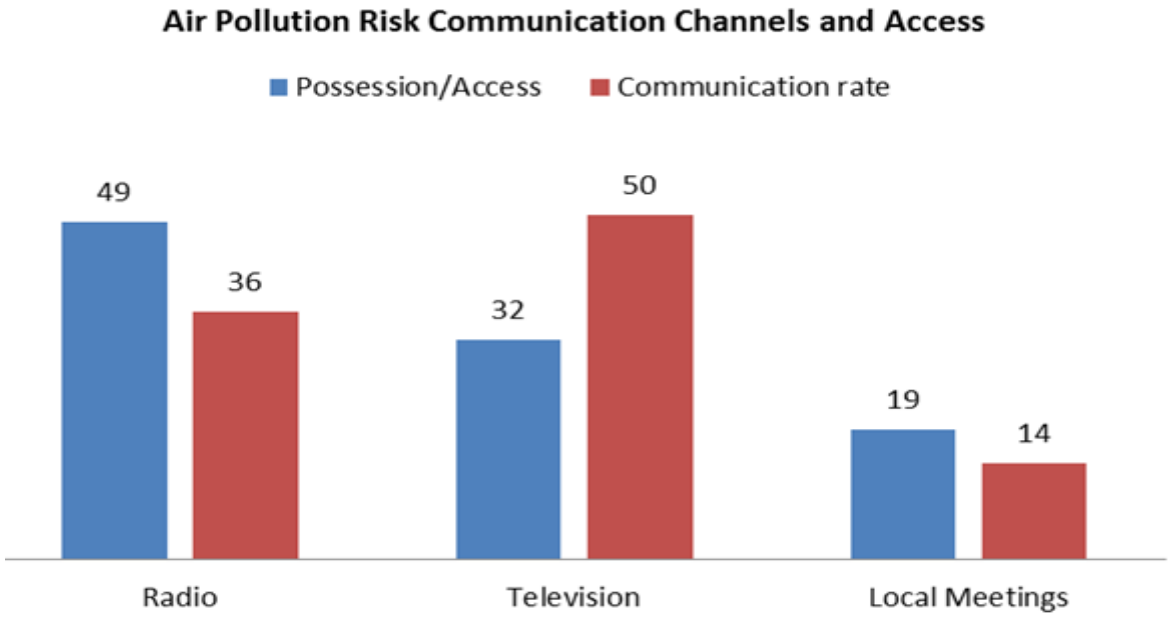


**Figure-3.** Channels of Air pollution Risk Information sharing and access.

Moreover, as the risk awareness information is not regularly reaching the target people, it can be noted that the resulting consequences are high, which is confirmed by the findings of this study, as shown in Figure 4, where 43 percent of residents and leaders, mentioned health effects as the primary consequence of air pollution and acid rain (37%). These two consequences (health effects and acid rain) may severely impact on the community's livelihood due to the fact that, the rainwater used for many household activities is already acid and/or unsafe. While the natural resources such as water which could replace the acid rain was also highlighted by 20 percent of respondents to be polluted as a result of air pollution.

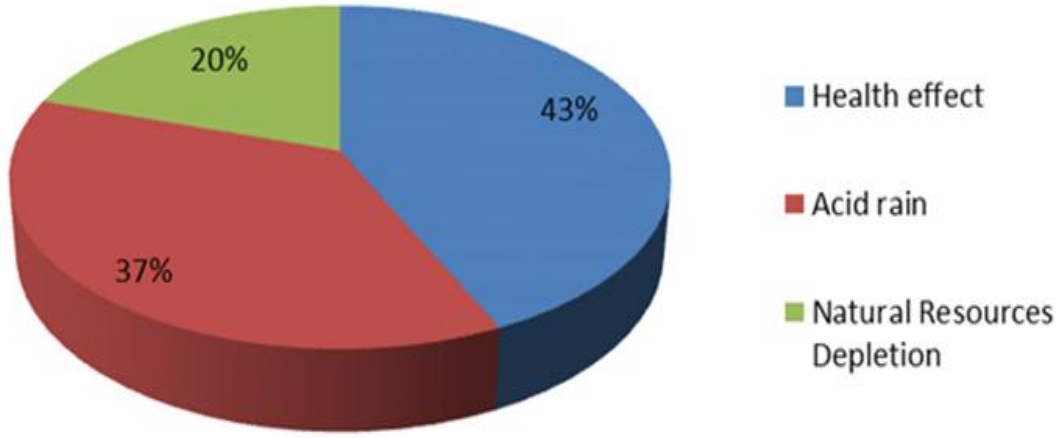


**Figure-4.** Consequences of air pollution in Kigali city.

It is worthy note that, due to the air pollution sources under record in Kigali city Figure 2 the tools used to reach the community and the extent of risk awareness among residents Figure 4, the consequences are likely to increase, and this expresses that, there is still much to be done to ensure the reduction of the air pollutants.

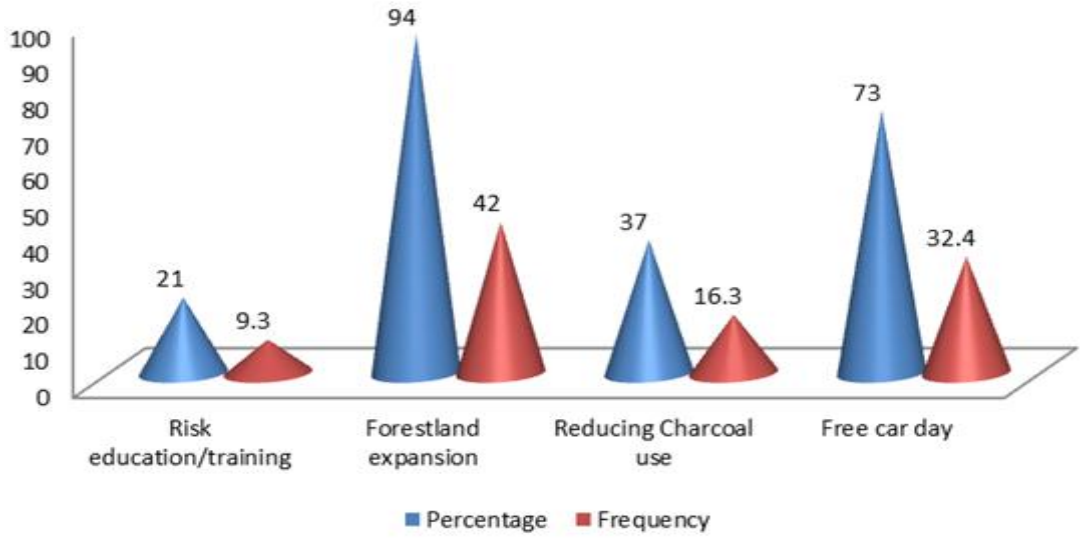


**Figure-5.** Practical air pollution risk reduction measures.

As shown in Figure 5, the air pollution risk reduction may likely fail due to the low extent of providing the risk education/training mentioned by 9.3 percent, which should be used to reach a large number of people and easily transmit the massage for the air pollution risk reduction.

## 4. DISCUSSION

The air pollution generates detrimental human health and environmental effects, and the exposure reduction requires appropriate action at the national, regional and international levels. Globally, the air pollution is increasing with severe risk, mainly among pregnant women and children bellow age of five years. Although the problem is common to poor and industrialized countries, the risk is managed differently due to the available capabilities and the most concern about air pollution, among others, is the health effects (Seinfeld and Pandis, 2016; De Verteuil and Isaac, 2017). This is similar to Kigali city, as shown in Figure 4, under health effects (43%) as the major air pollution risk. These health effects can be immediate such as aggravated cardiovascular and respiratory illness, heart and lung stress and the damaged cells in the respiratory system, or long term health effects such as the loss of flung and decreased lung dysfunction, accelerated aging of lung, asthma, bronchitis and possibly cancer (Amegah and Jaakkola, 2016; Vert *et al.*, 2017). Thus, such air pollution generated health effects may be recorded in Kigali city, due to the reason that the main sources of air pollution Figure 2 are daily human activities and the major risks recorded Figure 4 are health effects than others.

This greatly suggests to the city managers to recognize the fact that, urbanization activities in Kigali city are expanding under its dwellers reported (Nsanzimana *et al.*, 2015) to gradually increase at high rate (4% annually) along with migrants from other provinces of the country in search of good living condition. Thus, the community and local leaders working together, as previously reported (Honkalaskar *et al.*, 2017) would help to easily identify to the residents the primary air pollutants, share the air pollution risk information and reduction measures implementation in a participative manner. However, this may fail in Kigali city, due to the fact that, as shown by the findings of this study Figure 3 the use of local meetings, where a large number of people can be easily met and radio possessed by many people (49%) is at low extent compared to that of television (50%) possessed by a low percentage (32%) of the respondents. Therefore, the way air pollution risk information is shared in Kigali city reveals the

likelihood of increasing the air pollution sources and risk, specifically resulting on the reason that, the community that could help in reducing the emission sources is not aware of the risk Figure 3.

Similarly, as illustrated in Figure 5, the air pollution risk education/training (9.3%) which could help in analyzing the air pollution trend and easy information sharing with the residents, is at low level compared to the car free day (32%) and forestland expansion (42%) initiated to reduce and absorb the emission. In addition, as the residents of Kigali city, predominantly young Table 1 are not approached through education and/or training to enhance its risk awareness, the air pollution trend will keep under record, with further risk on the residents' wellbeing and environment. Moreover, this may lead to the failure of the initiated measures such as car free day and forestland expansion, due to the fact that, the residents' behavior is not changing, as a result of lack of appropriate approach. Therefore, this expresses the need of strengthening the provision of air pollution related education within the education system and local training for adults, to strengthen residents' risk awareness, provide much-needed skills and knowledge, and empower the local decision makers in terms of implementing appropriate air pollution risk reduction measures. Furthermore, there is need of improving information sharing for the polluters' risk awareness, health risk minimizing and help in first comparing air pollution risk with planned development activities before implementation.

## 5. CONCLUSION

This study assessed the air pollution risk awareness and a face-to-face interview was conducted with two hundred and twenty five (225) respondents (30 local leaders and 195 residents) randomly selected among the residents of Kigali city in May 2018.The results revealed that the air pollution risk information is not reaching the target people, as it is shared through television at large extent (50%) than radio (36%) possessed by 49 percent of the total respondents. Therefore, for air pollution risk reduction and awareness in Kigali city, the findings suggest more efforts in providing air pollution risk related education from primary to graduate level, local meetings and trainings toward changing the residents' attitude and behavior. This will strengthen the community's air pollution risk awareness and reduce the sources, while conducting regular air pollution risk monitoring, forecasting and appropriate information sharing would be another good option in reducing the risks to both human health and the environment in general.

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