Dynamics of pollution from bush burning: Analysis from first principles

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Abstract. The hazards of bush burning are enormous to human health and climate system. The study looks into the dynamics of bush burning with the focus to develop a recovery plan for regions with poor atmospheric ventilation. The analysis was considered using the first principles on air pollution. Varying initial and boundary conditions were considered to derive the best outcome.

1. Introduction
Bush burning refers to the act of setting timberland, weeds and even the grasses ablaze. Bush burning has had a massive effect on the environment and even the health of mankind; it leads to the creation of air pollutants, such as Sulphur oxides, carbon monoxide, hydrocarbons, hydrogen sulphide, ozone and other oxidants or particles, for example, smoke, fog and exhaust are shaped amid the procedure of bush burning. It reduces the fertility of the soil as it causes damages to trees and crops. When land is burnt some of the required nutrients are nowhere to be found; the effect on the soil during the process of bush burning depends on the fire intensity. The bush fire can be as result of natural or artificial (man-made) fire. Shrub consuming effectively affects its condition, for example, low permeability by particles of issue [1-4]. It as well leads to some respiratory diseases nitrogen and Sulphur oxides may lead to the disorder of the respiratory system.

Aside from the termination of the soil and desert infringement brought about by shrubbery fires, it has also resulted to a remarkable increase in global warming due to the emission of some gases such as SO2, NO, CO, etc. which pose an impact on the ozone layer.

In Australia: Presently, Australia is faced with a heavy drought, which in return has led to frequent bush fires. In January 2003, a bush fire in the Australian Capital Territory burnt through a massive region, destroying 500 homes and led to the death of four people including the cattle and sheep in thousands. The impact leads to a massive evacuation. Portugal has faced some of the deadliest bush fire occurrence in Europe. In 2005, major bush fires occurred [5]. The greatest of them struck northern Lisbon and progressed even 13miles. It destroyed large forest regions and led to the killing of eighteen people. In Russia forest fires are ignited from lightening and as a result becomes difficult to stop. Previously Russia has fought bush fires that killed thousands of people including animals and destroyed useful materials including helicopters. In 2006 bush fires as a result of lightning occurred in the Halkidiki peninsula destination. More than a thousand tourists were evacuated. While in the year 2007, more than 60 people were killed from forest fires that blazed from the north to the south of Greece. In 1997 a great wild fire which was human induced occurred and was made worse by the El Nio effect. Countries such as Philippines were affected. Breathing became a problem. 10 million hectares of land was burned to the ground [6].
The causes of bush burning include Nature (Volcanic Eruptions, Lightning) and Humans (Arson, Fire work, Cigarettes, Unattended Campfires, Burning Debris). The type of gas pollutants that are emitted during bush burning includes: Carbon Monoxide, Sulphur Oxide, Hydrogen Sulphide, Nitrogen and Methane. The microorganism that can be introduced into the atmosphere by bush burning includes: cyanobacteria and algae, aerobic heterotrophic bacteria, mycelium and fungal propagation. This kind of pollution cause Asthma, Damaged respiratory system, Coughing, Palpitations, Tightness of the chest, Irritation of the lungs, nose, throat and eyes and Chest pain [7].

Hudson believes that plant food including essential nitrogen lost in smoke during forest fires, also the wood burnt constitutes of valuable potash, but it exists in a very soluble form, bush burning also is able to destroy humans, valuable environment and even helpful bacteria that exists in the upper region of the soil layer. Lawal, at el implied that the process of bush burning leads to the termination of micro-organisms that are very beneficial. The organic matter in the soil layers will be destroyed which will lead to the in-fertility of the soil thereby causing the soil to be useless. Bush burning increases soil erosion; the biota and the soil moisture is affected negatively. Cheda believed that bush burning leads to the loss of valuable organic matter, the bush fires also leads to an increase in soil erosion, deprives the soil of mulch and also litter. Nitrogen in the plant is also lost massively. Hinckley, most bush fires are related to the carelessness of campers who are fond of throwing their cigarettes around and campers who refuse to put off their camp fires. Duffey, bush burning is most effectively used by the conservationist in order to clear a rough land covered with vegetation which has been under grazed or even un grazed and where there has been a constant increase in the number of shrubs. Therefore, people use bush fires to eliminate grasslands and they forget about the environmental consequences. NEST, bush fire has become very useful, but the fire gets out of control that in return destroys the non-target forests. Thus, the forests fires are as a result of disregard of the value of grasslands, perhaps because of lack of awareness [8].

2. Methodology

In this section, a major criterion was the parameterization of the reaction-advection-diffusion partial differential equation (PDE). In this context, (unlike most assumptions in air pollution) the inter-relation of particulates (in form of chemical species) and flow fields (wind velocity, turbulent diffusivity, temperature) were considered. Hence, from first principle, equation (1) satisfies that condition.

\[
\frac{\partial C}{\partial t} + \text{div}(VC) = \text{div}(KC) + P(C, t) - L(C, t).
\]

C is the concentrations of all chemical species, V is the wind speed, K is turbulent diffusivity, and P and L represent production and loss terms due to chemical reactions, emissions and depositions. The explanation of equation can be found in Ref [9]. The solution of equation 1 was numerically solved using different values of the listed parameters to capture different events.

3. Results and Discussion

From first principle, concentration of pollutants or aerosols is localized away from the source of emission (Figure 1) at a time t. However, distance have huge role to play i.e. at certain distances, the concentration of pollutants or aerosols delocalized and reduce in concentration. However, at certain circumstances due to strong wind reversals, the concentration increase in a sinusoidal pattern i.e. depending on the topography of the geographical location (Figure 2).
The third scenario of the first principle is when a steady wind system aids the distribution of pollutants concentration. In this case, the concentration reduces as the pollutants spreads out as shown in Figure 3. In the process, any violent wind system may have little or adverse effect on the concentration of the pollutants (Figure 4).
The last case of the first principle is when the pollutants are dispersed in a very turbulent scenario. In this case, there are sinusoidal perturbations to the scenario described in Figure 1 as presented in Figure 5. In the reversed state, the perturbation still occurs (Figure 6).
4. Conclusion

The solution to solving bush burning includes: Public Awareness; There should be a need for the orientation of the general public. The public should be aware of the need to preserve the forests and put a stop to the destruction of the bushes by fires; Other alternative forms of cooking fuel; the application of other cooking fuels should be in use in some rural areas thereby discouraging people from using wood as fuel; Trees should be removed from regions where power lines are located or where some trees could be displaced onto foul power lines during the cause of a very heavy storm; In areas of high risk, the infrastructure of the utility should be based underground or a use of technology that a massive reduced forest fire risk; Remote sensing systems should be used in the area bushfire surveillance in order for swift monitoring and also detection.
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