Research proposal outline

Capacity of Urban Plants on Capturing Suspended Particulate Matters and Relation to Heavy Metal Accumulation

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Keywords: Heavy metals, air pollution, urban plants, dust capturing capacity

Background and problem statement:

Environmental pollution is any discharge of material or energy into water, land, or air that causes acute or chronic detriment to the earth's ecological balance or that lowers the quality and standard of life (Zehra et al. 2009). Pollutants may cause primary impairment, with direct identifiable impact on the environment, or secondary damage in the form of minor perturbations in the delicate balance of the biological food web that are detectable only over long time periods (Gheorghe and Ion, 2012). Industrial processes are causing continuous discharges of effluents into open drains which enter the environment that is being contaminated from variety of pollutants including heavy metals(Singh et al. 2010). The natural vegetation along the drains is under metal contamination stress (Zehra et al. 2009).There are a number of heavy metals of concerns that include arsenic (As), copper (Cu), zinc (Zn), lead (Pb), cadmium (Cd), and mercury (Hg) (Singh et al. 2010). The metal accumulation in both urban and rural conditon may affect ecosystems including plants and animals and has been causing a serious threat to human health (Bradl 2005). Hazardous air pollutants are released from a variety of manmade sources including industry, the combustion of fossil fuels, vehicular traffic, energy production and agriculture open burning. A large fraction of hazardous air pollutants are heavy metals, including toxic trace elements such as Cu, Zn, Pd, Cd, and Cr. Vehicular transportation is responsible for re-suspending and mixing fine particles in street dust (Zhang et al., 2012). Heavy metals in dust can exert direct effects on public health because they can easily enter the human body via breathing, dermal contact, and dust ingestion, ultimately damaging the tissue of lungs (Tchounwou et al. 2012). Heavy metals are naturally occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Their multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment; raising concerns over their potential effects on human health and the environment. Their toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals. Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority metals that are of public health significance(Tchounwou et al. 2012). It has been reported that plants may be used as biological filters by taking advantage of their foliar accumulation of particulate matter (PM) (Abou Seedo et al. 2017). Plants can also be used as effective biomonitors to detect the presence of metals, even at trace levels, in the soil and in the atmosphere (Sawidis et al., 2011). Toxic metals are readily accumulated in some plants and may pose a threat to humans and grazing animals(Boularbah et al. 2000). In recent years studies have reported the use of different plant parts as potential biomonitors of airborne heavy metals. Vehicle traffic born dust, open burning and industrial activities pollutants are the main ecosystem affecting causes(Science 2017). Urban vegetation is one of the most commonly cited ecosystem methods for reducing atmospheric pollutants (Gheorghe and Ion 2012; Science 2017), but the ability of different taxa to accumulate particulate matter and air-borne pollutants differs(Singh et al. 2010). The vegetation plays an important positive role in atmospheric purification and air pollutants reduction. The primary producers

represented by plants are an important component in biogeochemical cycles. The vegetation made exchanges with a part of the atmospheric gases by photosynthesis, respiration processes, and the final stage of litter decomposition which mineralization. Also, the leaves of the trees have an important role in retention of the particulate matters; dust capturing and heavy metal, they are mostly affected when the wet and dry atmospheric deposition increase. The plants play an important role in reducing atmospheric gases content, by photosynthesis. This reduction of atmospheric gases and heavy metal content has an important role in reducing of greenhouse gases, participating in reducing greenhouse effect and its consequences on climatic changes. Some previous studies have shown that trees and other vegetation are effective at trapping and absorbing many pollutant particles, and they can act as biological absorbers or filters of pollutants. Urban and peri-urban vegetation is being considered for air pollution abatement. Appropriate plants with efficiency to adsorb and absorb air-pollutants are the prerequisite for green space development. As Afghanistan especially Kabul and the majority of cities are continuously exposed to high amount of air pollution, smog, and heavy metal, thus it is necessary to find easy and cheap improvement methods. Taking advantage of phytoremediation, an ecological and friendly way to improve air quality, this study investigates the role of urban plant leaves in removing airborne dust, air pollution and its associated metals by analyzing leaf samples of urban plants.

Objectives: The objective of the study is:

1. To evaluate capacity of urban plant species on deposition/capturing of dust and suspended particulates.
2. To assess heavy metal accumulation and air pollution tolerance capacity of common urban plants.
3. To categorize and identify plant species with high potential of capturing dust/suspended particulate matters and heavy metals.

Methodology:

In this study heavy metals, air pollution and dust capturing capacity of urban trees will be assessed using common new adapted approaches and indices.

1. **Leaf Dust Capturing Capacity:** Leaf dust capturing capacity will be measured by gravimetric method (Prajapati and Tripathi 2008),and (Das and Prasad 2012).
2. **Heavy metal accumulation assessment:** Inductively coupled plasma optical emission spectrometry (ICP-OES 5110 Agilent Technologies) will be used during the elemental analysis of leaf samples (Molnár et al. 2020). Six-point calibration procedures with multi-element calibration solution (Merck ICP multi-element standard solution IV) will be used to measured concentration of heavy of metals including: Al, Ba, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, and Zn(Molnár et al. 2020).
3. **Air pollution tolerance capacity**: air pollution tolerance capacity of urban trees will be assessed using air pollution tolerance index (Roy et al., 2020).

Expected results and output of the study:

The proposed study is expected to:

- This study will identify air pollution tolerance plants.

- Common urban trees will be screen for heavy metal accumulation and dust capturing capacity.
- Determine the most useful, cheap and easiest air pollution mitigation techniques.
- The study can help policy maker to think in a broader way to make a policy for including recommended air pollution and heavy metals tolerance plants as a necessary part in all housing societies, urban and industrial areas to decrease noxious pollutants level.

Tentative timetable for the research project:

The study is expected to be completed within three years from the admission.

Activity	2021		2022				2023				2024	
	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr
Literature review												
Research proposal												
Designing experiments												
Conduction of experiments												
Data collection												
Data analyses												
Publication												
Publication												
Publication												
Thesis write-up												
Thesis submission												

The timetable of the research project is open to changes based on the discussion with the supervisor.

Note: This tentative research proposal is open to discussion and alteration based on the comments and recommendations of the supervisor. The proposed research plan could be modified in case this study is not applicable or is not in line with the ongoing research projects.

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