Buletin SEADPRI, Vol. 19, December 2019, ISSN 2180-1142

Research Highlights

Mangrove Forest Rehabilitation to Lessen Heatwave Casualty in Karachi, Pakistan

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INTRODUCTION

Karachi is the largest city in Pakistan with a population of 16.22 million, and the 7th largest metropolitan city in the world. Severe heat waves with temperatures as high as 49°C (120°F) have struck Karachi and southern parts of Pakistan since June 2015. It has caused the deaths of about 2,200 people from dehydration and heat stroke every year. In April 2017, a severe heat wave of 51°C (124°F) hit southern parts of the country and broke the old temperature records of many cities in the country for the month of April. The lack of advance meteorological forecasting technology contributed to the casualties of the heat wave disaster. The Urban Heat Island Effect further worsened the heat wave conditions. Heat waves are a symptom of global climate change; delay in monsoon rainfall cycle and extreme weather events aggravated by rapid urbanization, industrialization and motorization lead to high amount of CO^2 levels in the air creating a high temperature micro climate heat effect. Deforestation and degradation of mangrove forests have also worsened the situation.

Mangrove ecosystems play an important role in influencing the daily temperature, local environment and micro climatic conditions of Karachi, a city with a profound coastal environment. In Karachi, mangrove forests thrive at the mingling of saltwater and freshwater where the Indus River meets the Arabian Sea. Major threats to the forest are untreated municipal waste and industrial pollution causing still-undetermined amounts of damage. Most alarmingly, there is also exploitation of the trees for use as firewood, building material and fodder by communities in the area. As healthy forests absorb immense amounts of CO^2, it has the potential of providing essential carbon sinks. The mangrove forests extend over 132,000 ha, representing about 3% of the forest area of Pakistan, and supporting 97% of the total mangrove forests.

THE PROJECT

The Mangrove Forest Rehabilitation and Improvement Research Project (SUPARCO#19/A-2017-2019) was initiated by PODA and the China Agricultural University to apply GIS and Remote Sending (GIS/RS) along with the climate simulation modelling tools SILVA and SWAT in forestry practices. The aim is to contribute to increase plant population and forest areas as well as air quality index (AQI) by simulating the possible opportunities to mitigate extreme climatic changes in order to build resilience. The goal is to ensure environmental flows for a sustainable ecosystem, improvement in livelihood opportunities, and protection from climatic disaster, while integrating climate change-related information into the planning processes in formulating community development strategies to reduce the risk of disaster.

Within the first year research project, six follow-up studies emerged. These studies include climate-change scenarios development, mangrove forest cover change analysis under different hydrological regimes, environmental flows assessments under different ecological - conditions, salinity distribution due to sea level rise, socio-economic assessment, and institutional and policy analysis. More advanced and complex scientific modelling techniques are required for detailed impact studies in the region. The anticipated rise in temperatures and frequency of heat waves in the country demand a comprehensive strategy to cope with this type of disastrous events in future.

KEY FINDINGS

The project recommends the establishment of Heat-Health Warning System targeting the vulnerable segment of the urban centres. The warning system will have essential components of monitoring and warning service, dissemination, and communication of the heat wave risk to the communities thus enhancing their response capabilities to better cope with this situation. After the onset of monsoon rainfall, the project team mobilized and educated local communities about the importance of mangrove forest for themselves and Karachi city. Mega level planting of mangrove plants was organised with the participation of local community groups, women and youth.

SILVA model simulations showed two-thirds of the Karachi CO^2 stock can be deposited by mangrove forests which contribute 19% of the mangrove ecosystem. The model projected that the forest area has the ability to absorb CO^2 emissions of up to 55.4 million tons. Inter-comparison of SILVA and SWAT Models' validation skill scores showed that the forests have a huge potential to contribute to global efforts to reduce carbon footprints through climate-smart practices of restoration, afforestation, conservation, reforestation, and sustainable management of mangrove forests. SILVA estimated that the forest population has excellent sink capacity to absorb maximum atmospheric carbon to combat global climate change impacts and efficiently manage REDD+, so it contributes to improvement of the AQI and HW of Karachi.

A heat wave casualty is drenched with water to lower the body temperature. Pakistan experienced a severe heatwave with a record temperature of 51°C (124°F) in 2017.

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The project provides an assessment on changing meteorological conditions and its resultant land cover changes through a temporal GIS/RS analysis.

Several suggestions are made to reduce the impacts of heat stress. Rehabilitation and reforestation of mangrove forests need to be implemented on a wide-spread basis. Meteorological forecasting of monsoon cycles need to be advanced with proper early warning systems. Awareness campaigns need to be enhanced to increase the capacity of individuals and communities to respond to heat stress during heat waves. Increased green spaces and green roofs play contribute to decreasing the urban heat island effect. In adddition, the urban heat island effect can be counteracted slightly by using white or reflective materials to build houses, roofs, pavements and roads, thus increasing the overall albedo of the city. 'Cool Centres' facilitated with drinking water, fans etc. could be established at public places and along the main avenues, besides protection and development of tree-shaded rest areas. Cool Centres' facilitated with drinking water, - fans etc. could be established at public places and along the main avenues, besides protection and development of tree-shaded rest areas.

CONCLUDING REMARKS

The lack of advance meteorological monsoon forecasting system have contributed to the casualties of the heat wave disaster in Karachi since 2015. The Urban Heat Island Effect further worsened the heat wave conditions. Monitoring and mapping of mangrove forest area using GIS and remote sensing is crucial to estimate damage by deforestation and degradation and its impact assessment on Karachi. The establishment of Heat-Health Warning System targeting the vulnerable segment of the urban centres is proposed. Regional level application of SILVA and SWAT modelling in forestry practices and simulation of the possible opportunities to mitigate extreme climatic changes can contribute to build disaster resilience. The models project that mangrove forest areas in Karachi have the ability to absorb 55.4 million tons emissions of CO^2.

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