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Reed Bed Technology and Recharging on Groundwater: Mitigating the Climate Effect of Coastal Areas

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Abstract

Reed Bed municipal treatment technique is introduced which will surely play an effective and actual role in climate change and environment. Knowledge and skills will expand to the other community and this will contribute to healthy atmosphere. The major areas to be focused here are plantation, recharge of groundwater, irrigation for coastal, arid and semi-arid areas. Technology will therefore helpful in climate change and awareness regarding the wastewater contamination, especially stakeholder by mobilization activities and their capacities will be built as to how to minimize the contamination and recycle the water at micro and macro level. It produces quality fertile water for irrigation purposes. Presently fresh water is being used for irrigation and planting and fresh water will be saved. It is economical and cost-effective tool and study will contribute to avoid making water deficient sustainability.

Keywords: Reed bed; Climate change; Recharging; Ground water; Contamination

Introduction

Karachi is seventh largest populated metropolitan in the world and fourth in the region having 16.6 million populations much higher than projected in 2015-16 and this is assuming fastest growth of any metropolitan in the globe. Rapid population growth is expected about 24 .8 million to make the metropolitan stand on seventh largest in the globe by 2030 and the growth rate is too higher and has been recorded in recent 2017 census [1].

Metropolitan lies in arid climate zone and is dominated by a long summer season, while it is toned-down by Arabian Sea or Indian Ocean influence. Karachi received low annual average precipitation approximately 250 mm per annum, and the bulk of precipitation occurred during monsoon months of July to September. Metropolitan has also prone to deadly heat waves. Metropolitan received 429.3 mm highest rainfall during July 1967 and 278.2 mm (10.95 inches) is longer rainfall received for 24 h during August 7th of 1967 which has been lashed the city resulting major flash flooding. Karachi cosmopolitan faces fresh water shortage since 2001. Karachi Water and Sewerage Board (KWS&B) is central authority to maintain the sewerage treatment and water supply. Cosmopolitan current water demand is about 1200 million gallon per day (MGD) but due to sever scarcity of water only 350 MGD is supply to end user, while KWSB has insufficient treatment facilities to cater the domestic treatment. Most of this domestic sewage is dispose-off in Arabian Sea without primary treatment [2]. Conventional and advance treatment technologies are financially not feasible while Reed bed is alternative economical solution for treatment of domestic sewage treatment with target to achieve the sewage treatment as well as carbon capturing through flourishing of reed and trickledown the incremental temperatures. Reed bed is one of the natural and cheap methods of treating domestic, industrial and agricultural liquid wastes [3].

Heat waves are meteorological actions that have established much consideration in modern years, given the mortality related with them [4] and specified the image of increases in their incidence, period, and strength as part of global climate change. For decades, most analyses of long-term global climate change using observational heat and rainfall data have paying attention on changes in mean values. Numerous well respected monthly data sets give sound spatial reporting across the globe. On the other hand, analyzing changes in extremes, such as changes in heat wave period or in the number of days during which temperature exceeds its long term 90th percentile, requires day by day data in digital form. Unfortunately, these figures are not readily presented to the international research society for large portions of the world [5]. In previously “global” investigation of severe indices by [6,7], there were almost no data for most of Central and South America, Africa, and southern Asia.

Xianfa and Jiang [8] have experimentally studied different technologies of wetland system i.e., cost effective for water pollution control in China. In their research they introduced land treatment systems, and constructed wetland and integrated reed bed wetland-lagoon system in North Chin. The operation of reed bed wetland systems is stable and efficient with no seasonal effects. The water quality standard of recycle water and the treatment cost is 37% of that of conventional secondary treatment. It is expected that after two or three years' operation, the organic matter level in soil will increase, and this result will be suitable for tree planting and coastal area afforestation. The wetland systems which can not only treat wastewater, but also improve saline-alkali soil, have synthetically economic and ecological benefits. Reed is not only a valuable cash crop, but also a "filter" for wastewater. Besides removing conventional pollutants, the reed bed wetlands can also remove heavy metals and trace organic compounds by 70% to 100%. Jürgen Kern and Christine

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Idler [9] have reported that the purification capacity and seasonal variability of two newly created reed bed systems was monitored over 1 year. In one of the systems treating domestic wastewater, the reduction in the concentrations of chemical oxygen demand (COD), total N, total P and fecal coliform bacteria (FC) ranged from 80% to 99%. In the second system, treating a mixture of domestic and agricultural wastewater produced by a cheese dairy, treatment efficiency ranged between 13% and 99%. The removal rates did not show any seasonal pattern for domestic wastewater, in contrast to the mixture of domestic and agricultural wastewater with increased removal rates in the summer. Reed bed systems have proved to be an appropriate technology for cleaning municipal wastewater.

It has been recognized in the technical literature that effects of anthropogenic climate change expand beyond changes in the mean and cover adverse shifts in extremes. Certainly, the matter of climate extremes is of large attention globally because of their high economic, human being, and physical impacts [10,11]. Eleonora [12] has elaborated that the Reed bed systems (RBS) represent an innovative and ecologically sound treatment method for the stabilization of sludge from wastewater treatment plants (WWTPs), which is also able to provide several ancillary ecosystem services. In this study, the performance of sludge stabilization achieved during the operation of an RBS for the stabilization of excess sludge extracted from a wastewater treatment plants (WWTPs) located in Central Italy was studied. The main aim of this paper is to monitor the stabilization process of sludge organic matter occurring during the main RBS operational stages (commissioning, operation and resting), in order to derive useful rules and parameters for the formulation of novel guidelines for RBS design. This study demonstrated the pathways of organic matter stabilization occurring in a sludge stabilization reed bed during a complete 72 month-long cycle. Brix (2017 have studied the Sludge Treatment Reed Beds (STRBs) are widely used in Northern Europe to dewater and mineralize surplus sludge from activated sludge systems used to treat urban domestic sewage. The author describes the basic design and operation requirements of STRBs, with special focus on pivotal requirements to respect in order to secure proper functioning. This paper summarizes performance experience concerning final dry matter content, degree of mineralization, emission of greenhouse gases, and degradation of micro -pollutants in STRBs. Compared to conventional sludge handling techniques, Sludge Treatment Reed Beds (STRBs) are low-technology, energy-efficient, and do not require addition of chemicals. STRBs dewater and stabilize the sludge and produce a final product that can be safely disposed of or used for agricultural purposes The CO_2 emitted from STRBs should not be considered a problem in relation to the greenhouse effect. It has been shown that STRBs emit 2 to 9 times less CO_2 equivalents than conventional treatment methods and that greenhouse gas emissions make an insignificant contribution to the total carbon footprint of STRBs compared to raw materials and energy consumption. STRBs seem to be a good alternative for sludge treatment in terms of climatic impact. It is relevant, however, to make sure that greenhouse gas emissions from an STRB are not higher than necessary, and that the contribution from CH_4 is kept to a minimum. The capital costs of STRBs are usually higher than mechanical dewatering devises. However, the operational expenses are significantly lower than those of mechanical dewatering, delivering an economic break-even of about 3–5 2015 (18-23, June) Pakistan a severe have heat wave (temperatures as high as 40°C to 45°C) due to humidity levels ranging 40% to 50% hit southern Pakistan. Deaths was about more than two thousand from dehydration and heat stroke mostly effected Sindh province and its capital city, Karachi [13,14].

Zoo animals lives and countless agricultural livestock also [15,16]. During this event in neighboring India the deaths were 2,500 in May 2015 [17]. Temperatures started to grip Pakistan's southern areas on last week of June 2015 and peak was on 20 June [18,19].

Director General of the Pakistan Environmental Protection Agency Asif Shuja (former) was claimed that heat wave symptom was of globally change and aggravated by deforestation and rapid urbanization. He maintained that "there has been a rise in the Earth's average temperature from 15.5°C to 16.2°C over the last 100 years, due to which

We are experiencing such extreme weather conditions both in summers and winters. He also says that the lack of sophisticated weather prediction technology in Pakistan contributed to the casualties of the heat wave [18]. The heat wave profile is shown in Figure 1.

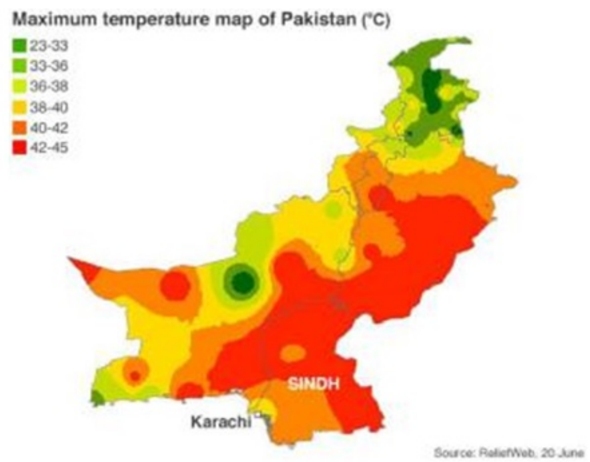

Figure 1: Heat wave condition in 2015, Pakistan.

Heat Wave Scenario in Pakistan

(NOAA's Climate Prediction Center poured some cold water on our hope that lots and lots of cold water would spread across the Pacific's midsection, perhaps even making a temporary dent in our global, carbon emissions-fueled heat wave. Last week, the La Niña watch was officially taken down. Forecasters are now placing their bets on ENSO-neutral conditions (aka, neither El Niño nor La Niña) persisting through the winter)

Electricity was failed in many areas and without working fans, air-conditioners or water pumps, increase losses of life [20]. Prime Minister of Pakistan was comprised a committee include Abdul Qadir Baloch (Retired General of the Pakistan Army) and State Minister of Health Sciences Regulation. Abdul Qadir Baloch says during visit to the media that K-Electric was being investigated for load shedding [21].

Government of Sindh, Karachi -Electric and KW&SB are responsible for the heat wave death in Karachi also said Abdul Qadir Baloch [22]. According to the NEPRA regulator reported that Karachi-Electricity was not generating according to its generation capacity [23].

During theRamadan Muslims were observing fasting and increased the risks of dehydration and heat stroke [24].

Emergency measures

Government of Pakistan also declared the emergency and military relief efforts [20] and Government also warned to the companies of K-Electric supply that they would not tolerate power outages during Ramadan. Sindh government also declared the emergency for all government hospitals in the province [25]. Pakistan is a Muslim country, decreed a fatwa that if "qualified doctor and religious" advises to the peoples (for life safety) that are allowed to skip or break their Ramadan and complete these days when Ramadan and emergency have passed [24]. Due to exceeded deaths, the local capacities for storage, as the emergency efforts proved lacking to prevent huge loss of life [16,26].

In order to lower down the extreme heat waves, a low cost technology named as "Reed Bed" can be introduced. It was introduced previously in Pakistan and Nepal also. Knowledge and skills will expand to the other community therefore contribute to ecosystem preservation and protection, resulting resilience to climate change and will contribute to healthy atmosphere [27].

Technology will help on the small scale and combine effects on large scale reduce the climate change effects, water shortage and down the temperature by plantation. The shallow water was at 42-80 ft with low TDS (500-2500 mg/l) but now it decreases to 100-150 ft (3000-9000 mg/l) in last five years and it is brackish water [28]. Reed Bed will technology recharges ground water and also makes the shallow water quality enhanced for the usage in several purposes [27].

Low cost technology

Reed Bed Municipal Wastewater Treatment Technology (RBMWTT) is a natural, low-cost, eco-technology to found in natural wetland ecosystems, environmentally-friendly, and can standing as the potential alternative or supplementary treatment system of wastewater. Study examines the effect of growing botanical diversity by reed-bed planting on municipal treatment and the possible enhancement of overall catchment biodiversity [29]. Climate change will have strong indirect effects on biodiversity in forests plantation by changes in forest management actions that have been planned to mitigate the effects of climate change on the productive capability of plantations and cultivated areas [30].

Methodology

Reed Bed (RB) technology can compares to conventional treatment plant however about two municipal wastewater treatment plants using Reed Bed technology in Karachi.

It is essentially a channel, lined with an impermeable membrane that is filled with gravel and planted with macrophytes i.e., reeds, rushes and used to treat wastewater [30]. Municipal wastewater (black or grey) is passed through the root zone of the where it undergoes biological treatment.

Inlet and outlet pipes are positioned below the gravel surface, so that the water always remains below the gravel surface thus excluding human exposure to the wastewater, mosquito breeding and unpleasant odours. Primary municipal effluent is treated initially, filtered prior to before entering the reed bed through screen and grid chambers for filtration processes. After filtration process the wastewater undergoes processes the reed bed. Reed beds are designed to retain the wastewater for a period of 5 to 7days. This residence time for treatment is sufficient for the settling and filtering of suspended solids and for nitrification/de-nitrification, fixation onto the substrate, breakdown of organic matter and nutrient removal via micro-organisms and plant uptake (Figures 2 and 3).

The generally residence time is governed by the surface area and depth of the reed bed. The die-off of pathogens in a reed bed is due to predation by micro-organisms on the surface of the gravel and roots, unfavorable conditions provided by a long residence time and the aerobic and anaerobic zones in the reed bed. Treated effluent water quality can improves with increased residence time. Plant will be constructed in line with the guidelines provided in constructed wetland manually (Figures 1 and 2).

Advantages of Reed Bed Technology

It can play a vital role in utilization of natural processes in which there can be interactions among plants, animals and the environment. The interactions may include photosynthesis, excessive plantation, deforestation, decomposition and others. This technology can be a worth and less expensive to build other than treatment options. It can be of simple construction, operation and easily maintained. Low construction and operation cost can be a major advantage.

Sewage treatment system will not only help reduce pollution but will also provide usable water for growth of various plants and trees in the area to conserve and preserve the ecosystems and it will be helpful for arid climate areas like Karachi. Quality of shallow water will lead to improvement and thus it is economic and odourless environment.

Result and Discussion

Baseline assessment of quality of municipal effluent water through collection and laboratory analysis of water samples from the effluent streams for pH, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) and Monitoring of water quality parameters of established Reed Bed system on a monthly and seasonal basis to assess changes against the baseline established for six months and used as advocacy tool with the policy makers. Impacts on ground water sources and investigate into other dimensions of the demonstrated pollution control measures by Warsi in 1998.

Samples were collected of feed and treated water and analyzes in the Environmental Research Centre Bahria University Karachi Campus [31]. Results of the RB plant in Tables 1 and 2 showing treatment efficiency 29.5% BOD, 20% COD and 42.8% TSS and treated water result values are in under the NEQs values. Whereas rainy water is increase the pollution load of feed water and treated water efficiency is decrease but under the NEQS values [32]. The result is comparable with USEPA standard value.

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Sr. No	Parameters	Units	*NEQS Limits	Waste water	Treated Water	Remarks
1	Total Dissolved Sold (TDS)	Mg/L	3500	863	1024	Under limit
2	pH	SU	06-Oct	6.75	7.37	Under limit
3	Biological Dissolved Oxygen	Mg/L	80	204	60	29.50%
4	Chemical Dissolved Oxygen	Mg/L	150	489	102	20.80%
5	Total Suspended Solid (TSS)	Mg/L	150	214	91.8	42.80%

Table 1: Results of Reed Bed System of Wetland Aziz Bhati Park Gulshan-e- Iqbal Karachi before rain dated 12-6-2015.

S. No	Parameters	Units	*NEQS	Waste	Treated	Remarks
			Limits	Water	Water	
1	Total Dissolved Sold (TDS)	mg/l	3500	872	903	Under limit
2	pH	SU	06-Oct	6.88	8.33	Under limit
3	Biological Dissolved Oxygen	mg/l	80	398	34	8.50%
4	Chemical Dissolved Oxygen	mg/l	150	772	66	8.50%
5	Total Suspended Solid (TSS)	mg/l	150	231	87	37%

Table 2: Results of Reed bed system of wetland Aziz Bhati Park Gulshan-e-Iqbal Karachi after rain dated 12-8-2015.

Results of the RB treatment plant in Table 3 is also showing treatment efficiency 12.8 BOD, 13% COD and 6.8% TSS and treated water result values are in under the NEQs values [32]. Whereas Figure 2 is showing that this RB treatment plant is excluding human exposure to the wastewater, mosquito breeding and unpleasant odors and recharging of ground water.

Figure 2: Reed bed system of wetland Aziz Bhati Park Gulshan-e-Iqbal Karachi dated 12-8-2015.

S. No	Parameters	Units	*NEQS Limits	Waste Water	Treated Water	Remarks
1	Total Dissolved Sold (TDS)	mg/l	3500	915	1452	Under limit
2	pH	SU	6-10	7.2	7.1	Under limit
3	Biological Dissolved Oxygen	mg/l	80	102	13	12.8%
4	Chemical Dissolved Oxygen	mg/l	150	194	27	13.9%
5	Total Suspended Solid (TSS)	mg/l	150	162	11	6.8%
*NEQS=National Environmental Quality Standard (Gazette of Pakistan) 10th August 2000 (NEQS, 2000)						

Table 3: Results of Reed bed system of wet land PNS Karachi after rain dated 12-8-2015.

Figure 3: Reed bed system of wetland Aziz Bhati Park Gulshan-e-Iqbal Karachi dated 12-8-2015.

Conclusion

RB technology is very helpful, healthy environment, very suitable for arid climate areas. We can save fresh water and mitigate climate change effects and environmental issues.

Greenery through reuse of waste water contributes to sequestration of CO_2 as pollutant from the sewage water will be removed. Technology will help reduce and minimize the climate change effects. Knowledge and skills will expend to the other community therefore contribute to ecosystem preservation and protection, resulting resilience to climate change and healthy atmosphere.

Awareness regarding the waste contamination by stakeholder mobilization activities and their capacities will be built as to how to minimize the contamination and reuse waste. Produce quality fertile water for irrigation purposes. Fresh water will be saved and used for other important purposes human being. There should be some proper working on Reed Bed Technology in future in order to make plantation and gardening easier. There should be maximum utilization for the betterment of the plantation and gardening issues so that quality of shallow water could be improved through this technology. This can lead to future sustainability.

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