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RHIZO-FILTRATION OF CEMETERY AREA GROUNDWATER POLLUTION BY USING AQUATIC PLANTS

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Abstract: This paper examines potential uses of naturally growing aquatic plants for groundwater purification of cemetery areas. The burial of corpses in cemeteries and their subsequent degradation may potentially cause pollution of ground water. The groundwater samples are taken around the cemetery areas in both rural (Aruppukottai, Kariapatti) and urban sides (Madurai). The samples are analyzed for pH, Turbidity, Total dissolved solids, Total alkalinity, Total hardness, Electrical conductivity, Nitrate, Fluoride, Chloride, etc… Among the urban and rural cemetery area samples, rural area groundwater sample showed higher physical and chemical contaminants than the urban. The aquatic plants are chosen in such a way that the contaminants present in the groundwater from both cemetery areas have more values than the permissible limits. These plants enhance the removal of pollutants by consuming part of them in the form of plant nutrients. Two aquatic plant species are taken in this study. They are Water hyacinth (Eichhorniacrassipes) and Cattail (Typha latifolia). Finally experimental result shows that between these two species of plants, Cattail showed better growth than the Water hyacinth in the groundwater samples taken from cemetery areas. Beyond the growth, it also removed contaminants within 25-35 days from a water sample of 3.5 litres.

Keywords: Aquatic plants, Cemetery, Groundwater, Physical and Chemical parameters.

1. INTRODUCTION

Agriculture, industry and landfills are commonly believed to be major anthropogenic sources of environmental contamination. However, little attention has been given to cemeteries as possible pollution sources. Research conducted on the latter has been limited to examining pollutants emanating from the bodies. However, cemeteries are not only the final resting place to bodies but also to coffins and caskets used for the interment of remains. Indeed, recent studies conducted found the highest contamination arising from cemeteries originated from minerals that are released by burial loads. The minerals that are used in coffin-making may corrode or degrade releasing harmful toxic substances. These may be transported from the graves through see page and diffuse into surroundings oils. From there they may leach into ground water and become a potential health risk to the residents in areas surrounding the cemetery. Most existing cemeteries were sited without thinking about potential risk to the local environment or community. Toxic chemicals that may be released into ground water include substances that were used in embalming and burial practices in the past as well as varnishes, sealers and preservatives and metal handles and ornaments used on wooden coffins.

1.1 Biological process of contamination

Cemeteries are laboratories of decomposition. The human body is a complex structure therefore the final products of decomposition are several: volatile fatty like acid butyric and propionic, primarily breakdown products of both muscle and fat, amino acids, fatty acids, ptomaine (skatole, indol, cadaverine and putrescine) and end products like: ammonia, ammonium compounds, hydrogen sulphide, methane, carbon dioxide and phosphoric acid. Whenever a cadaver is buried there are several alterations. Soft tissue starts to decompose a few hours after death due autolyse mechanisms (VASS *et al.*, 1992), followed by a process of fermentation due to the action of endogen bacteria, mostly located in human intestine. The process includes a first stage anaerobic, followed by others, provided from aerobic and anaerobic facultative bacterial groups. Besides bacteria, other microorganisms, like saprophyte fungi and diverse entomofauna act during putrefaction of cadavers. There are four principal phases of human body decomposition – chromatic, gaseous, humorous and skeletonization – however, in the ambit of the present study, the gaseous and the humorous are the most important. The leakage from the disposal sites of the buried human bodies is very slow and the most part of the water evaporates simultaneously when it is released and only observed around the burial site. However, the unsaturated zone will be impregnated with fatty substances, and intermediate nonvolatile products, resulting from the process of decomposition. Subsequently these products can be percolated through the soil to the water taken after precipitation, and contaminate the groundwater.

Moreover these all are the possible ways to groundwater contamination due to burial corpses and subsequent degradation in the cemetery areas.

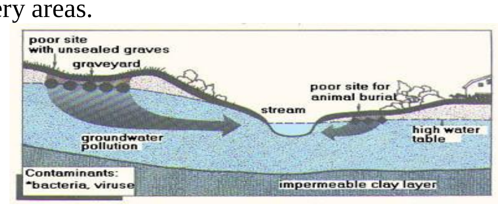

Fig 1.1 Process of Groundwater Pollution

1.2 Risk to groundwater

Generally the risk to groundwater is highest for larger cemetery developments or those with a high rate of burial, particularly if they are located on free draining ground with a shallow water table. Therefore the scale of development, local conditions and site specific factors (i.e. geophysical and biogeochemical conditions) need to be taken into consideration when identifying and quantifying the potential risks of a cemetery development.Dedicated management of the more complex cemetery sites is needed to prevent incorrect spacing between graves, in appropriate depth of burial, poor attention given to groundwater levels and insufficient monitoring of groundwater levels and quality.

The main potential polluting substances associated with burials and which may require monitoring in the event of leachate breakout are:

- Formaldehyde: a biocide with toxic and carcinogenic properties used as an embalming fluid and in coffin manufacture in resin glues.
- Ammoniacal nitrogen: a non-hazardous polluting substance released as an organic breakdown product.
- Mercury: a hazardous substance present in amalgam in dental fillings
- Pathogens: released from the decomposing bodies including bacteria, viruses, unicellular and multicellular eukaryotic organisms.
- Phosphate from the decomposition of skeletal remains.
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1.3 Phytoremediation Technique

1.3.1 Rhizo-Filtration

Rhizo-Filtration is a type of phytoremediation, which refer to the approach of using hydroponically cultivated plant roots to remediate contaminated water through absorption, concentration, and precipitation of pollutants.

Phytoremediation is one of the water treatment methods, and is the concept of using plant based systems and microbiological processes to eliminate contaminants in nature. The remediation techniques utilize specific planting arrangements, constructed wetlands, floating plant system and numerous other configurations. The removal of groundwater constituents are achieved by different mechanisms like filtration, sedimentation, chemical precipitation, adsorption and uptake of vegetation, among these phytoremediation is the most cost effective technology. These system requires low maintenance cost and low land requirements.

1.4.2 Principles of Phytoremediation

The principles of phytoremediation system are to clean up contaminated water, which include identification and implementation of efficient aquatic plant; uptake of dissolved nutrients and metals by growing plants and beneficial use of the plant biomass produced from the remediation system. The most important factor in implementing phytoremediation is the selection of an appropriate plant, which should have high uptake of both organic and inorganic pollutants, grow well in polluted water and easily controlled in quantitatively propagated dispersion. The uptake and accumulation of pollutants vary from plant to plant and also from specie to specie within a genus. The economic success of phytoremediation largely depends on photosynthetic activity and growth rate of plants.

2. LITERATURE REVIEW

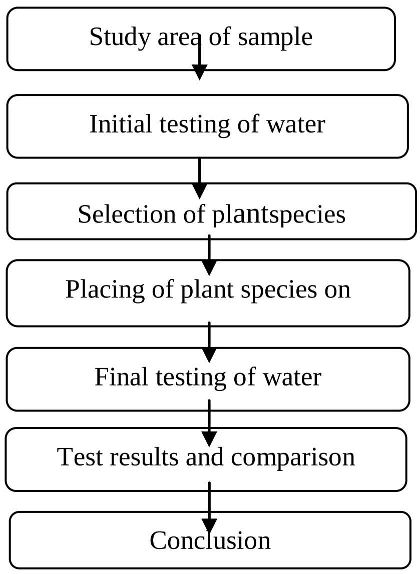
C.A. Byrne, A. Nankishore and A.A Ansari in 2015 "Wastewater Management Using an Aquatic and Semi-aquatic Plant Species, Cattail (Typha domingensis) and Duckweed (Spirodelapolyrhiza L.)" published in Journal of Agriculture and Ecology Research. Constructed wetlands are excellent chemical-free system, for reducing physico-chemical parameters and faecal coliform densities. Present research work was carried from 2013 to 2014 with the objective of wastewater management using two plant species cattail and duckweeds, singly and in combination. Other parameters such as NH3, DO, pH and turbidity, decreased in effluent from wetland containing cattails, duckweeds and both in combination. Other parameters such as EC, K, P, Cl and Na increased in effluent from one or more wetland trials. Faecal coliform reduction close to 47% was also noted. Absorption and uptake, by plants and microorganisms, appears to be the primary mechanism for nutrient removal, while parameters such as P and Fe are removed through formation of bonds with particles in the soil. The study revealed wetlands containing both floating and emergent macrophytes play significant role in improving wastewater quality.

Archana Dixit, Savita Dixit and C.S. Goswami in 2011 "Process and Plants for Wastewater Remediation: A Review" published in Scientific Reviews and Chemical Communications. Increasing urbanization, Industrialization and over population are the factors mainly responsible for adding hazardous components in water, which mainly constitutes heavy metals and chemicals etc. Water bodies are the main targets for disposing the pollutants directly or indirectly. This is a review paper illustrating the role of plants to assist the treatment costly and sometimes non-eco friendly also. Therefore, the research is oriented towards low cost and eco friendly technology for wastewater purification, which will be beneficial for community. The paper discuss the potential of different process and utilization of terrestrial and aquatic plants in purifying water and wastewater from different sources.

A.G. Fineza, E.A.G. Marques, R.K.X. Bastos, L.S. Betim in 2014 "Impacts on the Groundwater Quality Within a Cemetery Area in Southeast Brazil" This article presents the results of a case study carried out in the cemetery of Tabuleiro, state of Minas Gerais, Brazil, from August 2007 to March 2008. Five sampling wells were drilled within the cemetery area, and water samples analyzed for pH, conductivity, nitrogen ammoniacal nitrogen, nitrate, total phosphorus, sodium, potassium, calcium, manganese, BOD, COD, total coliforms and E. coli. The results demonstrated that the groundwater is subjected to contamination from burials leakage and the most evident impacts have been observed in the sampling well located downstream of the cemetery site.

3. EXPERIMENTAL PROGRAM

3.1 Methodology



3.2 Study area

- In this project, four cemetery areas(2 rural areas and 2 urban areas) were studied. They are Maapalayam (Madurai), Thathaneri (Madurai), Aruppukkottai (Virudhunagar), Kariapatti (Virudhunagar).
- Each cemetery areas showed different levels of contamination.
- The water samples are collected from nearby houses and also inside the cemetery area.

3.2.1 Mappalayam cemetery area

Mappalayam cemetery has an area of about 2500sq.m. Over 500 dead bodies were buried in that cemetery area. The dead bodies are only buried in this cemetery. This cemetery has no electric crematorium. Approximately 60 dead bodies are buried in that area per year. The age of this cemetery area is about 18 years.

Fig 3.1 Mappalayam Cemetery

3.2.4 Kariapatti cemetery area

This rural cemetery has an area of about 4250sq.m. Over 750 dead bodies are buried in this cemetery. This cemetery area has no burning facility. Only burying of dead bodies take place. This is the oldest cemetery area around Virudhunagar district. The age of this cemetery area is about 50 years.

Fig 3.3 Kariapatti Cemetery

3.2.2 Thathaneri cemetery area

This cemetery has an area of about 1850sq.m. In this cemetery area both burial and burning of dead bodies takes place. More number of dead bodies from Madurai city are either buried or burned in this cemetery. Approximately 80 to 100 dead bodies are buried this cemetery. The age of this cemetery area is about 30 years.

Fig 3.2 Thathaneri Cemetery

3.2.3 Aruppukkottai cemetery area

This is a rural cemetery having an area of about 3550sq.m. Both burial and burning of dead bodies take place. Approximately 400-500 deadbodies are buried in thiscemetery. Age of this cemetery area is about 30 years.

Fig 3.4 Aruppukkottai Cemetery

3.2.5 Collected sample

In this project, sampling of water is done by grab sampling on different cemetery areas. The sample is taken just nearby houses and also inside the cemetery areas. About 2 litres of water is taken from each cemetery areas and these samples are given for initial testing. Among four cemetery area water samples, the rural area water sample showed poor quality than the urban. So we have taken about 40 litres of sample from the rural cemetery area for the experimental purpose.

Fig 3.8 Sample 1 **Fig 3.9 Sample 2**

3.3 Initial testing

After collecting the samples from different cemetery areas, they were given to the Madurai district TWAD board for testing physical and chemical parameters. The basic physical and chemical parameters such as pH, Turbidity, Total dissolved solids, Color and Odour, Hardness, Calcium, Magnesium, Nitrate, Nitrite, etc.…Totally 21 parameters were tested.

3.3.1 Procedure for physical and chemical parameters

3.3.1.1 Turbidity

It is a measure of degree of opaqueness of water and interference presented by suspended matter to the passage of light. The turbidity is due to clay, silt, finely divided organic matter and microscopic organisms. Turbidity tests are important from aesthetic consideration and from the point of economics of treatment. The most important health significance of turbidity is that may, harbor pathogenic organisms. Turbidity of sample solution can be measured by using Nephelometer. It is usually measured in nephelometric turbidity units (NTU) or Jackson turbidity units (JTU).

3.3.1.2 Odour

Odour in drinking water may be defined asthatsensation that is due to the presence of substancesthathaveanappreciablevapourpressureandthatstimulatethehumansensoryorgansinthenasalandsinu scavities.The response to odour is complex and can leadtoconfusionbetweenthesensesoftasteandsmellincasesinwhichaweakodourimpartsa flavor toasubstance.Odour in water is usually measured in terms ofitsthresholdodournumber(TON).

3.3.1.3 Total Dissolved Solids (TDS)

Itis a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a filter with two-micrometer (nominal size, or smaller) pores. Total dissolved solids are normally discussed only for freshwater systems, as salinity includes some of the ions constituting the definition of TDS. It is generally measured in mg/L or ppm (parts per million).

3.3.1.4 pH

It is a numeric scale used to specify the acidity or basicity of an aqueous solution. It is approximately the negative of the base 10 logarithm of the molar concentration, measured in units of moles per liter, of hydrogen ions. More precisely it is the negative of the logarithm to base 10 of the activity of the hydrogen ion. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7, being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14 for very strong acids and bases respectively.

Fig 3.10 pH Meter

3.3.1.5 Hardness

The study of hardness is important from the point of view of industrial utilization of water especially in boilers, where scales are formed. Hardness in municipal supplies increases the consumption of soap, fuel; tea leaves etc… in the household an renders it unsuitable for use in air-conditioning. It is usually measured in mg/L.

3.3.1.7 Nitrate

Nitrates are inorganic compounds made up of nitrogen and oxygen, NO3 (one nitrogen and three oxygen molecules). These compounds combine with other elements like sodium and potassium to make sodium nitrate or potassium nitrate. They are used as preservatives and color fixatives in cured meats and have other industrial uses, such as in gunpowder, explosives, fertilizers, and glass enamels. It is measured in mg/L.

3.3.1.8 Nitrite

Nitrite (NO2) is not ordinarily found in high concentration in either surface water or in groundwater, but can be present as an intermediate step in the oxidation of ammonia or in the reduction of nitrate (NO3). Nitrite is therefore commonly present in samples from biological processes such as nitrification, de-nitrification or biological nutrient removal (BNR). Nitrite concentration and trend in process samples can be used as an indicator of biological process efficiency.

Table 3.1 Results from initial testing

Parameters	**Permissible Limits**	**Rural samples readings**		**Urban samples readings**	
Physical Parameters		**Sample 1(K)**	**Sample 2(A)**	**Sample 3(M)**	**Sample 4(T)**
Appearance	-	Turbid	Slightly turbid	Clear	Slightly turbid
Colour(pt, co-scale)	5-15	Brownish	Colourless	Colourless	Colourless
Odour (TON)	Agreeable	None	None	None	None
Turbidity (NTU)	1-5	8.1	2.8	0	2
Total Dissolved Solids(mg/L)	500-2000	3867	1472	1540	2100
Electrical Conductivity	-	5600	2100	2200	3000
Chemical Parameters	**Permissible limits**	**Sample 1 (K)**	**Sample 2 (A)**	**Sample 3 (M)**	**Sample4 (T)**
pH	6.5-8.5	8.5	8.1	7.10	7.50
Alkalinity	-	24	0	0	0

Total Alkalinity(mg/L)	200-600	1067	796	360	400
Total Hardness(mg/L)	200-600	1211	273	520	760
Calcium (mg/L)	75-200	331	72	130	190
Magnesium (mg/L)	30-100	90	20	50	76
Iron (mg/L)	0.3	0.71	0.23	0	0.2
Manganese (mg/L)	0.1-0.3	0	0	0	0
Free Ammonia (mg/L)	0.5	0.17	0.15	0.2	0.3
Nitrite (mg/L)	-	0.02	0.03	0.2	0.2
Nitrate (mg/L)	45	5	2	16	19
Chloride (mg/L)	250-1000	1045	83	440	560
Fluoride (mg/L)	1-1.5	1.5	1.4	1.0	1.0
Sulphate (mg/L)	200-400	511	41	52	64
Phosphate (mg/L)	-	0.2	0.05	0.2	0.3

3.4 Selected Plant Species

3.4.1 Study about Phytoremediation Plant

In this study selected type of plant species will able to extracts the physical and chemical contaminants present in the cemetery area groundwater samples. The plant species for this study were selected based on the literature review as well as considering biomass and phytoremediation efficiency for different contaminants present in the groundwater samples. Water Hyacinth (Eichhorniacrassipes) and Cattail (Typha latifolia) were the two plants species are selected as the part of this project. These two plants are taken from different areas, water hyacinth from Vaigairiver and cattail from Avaniyapuram (Madurai).

Table 3.2 Removal of Contaminants With Selected Species

Mechan-ism	Process	Media	Contam-inants	Plants
Rhizofilt-ration	Rhizosphere accumulation	Ground water, Wastewater lagoons or wetland construction	Ca, Ni and Fe Metals such as Cd, Cu, Ni, Pb and Zn.	Aquatic plants emergent (Cattail, Duckweed Bullrush)
	Contaminant extraction and capture	Ground water and surface water	Nitrite, odour, Turbidity and Ca& Mg	Water hyacinth

3.4.1.1 Water Hyacinth (Eichhorniacrassipes)

Eichhorniacrassipes is a floating plant and has an astonishing reproductive rate and its roots can directly absorb the suspended particulate.Water hyacinth is a prolific aquatic weed of cosmopolitan distribution with a huge potential for the removal of vast range of pollutants from waste water. All these models show logistic growth in the plant, and are dependent on environmental factors. According to the water hyacinth has an ideal characteristics for water purification and pollution control. The production of high quality vegetable protein, vitamins, minerals, fertilizers, chemicals and energy in the form of biogas from water hyacinth had reduced its nuisance value and made it potential provider. Although water hyacinth is an invasive plant in most countries all over the world, it is also used as a resource in agricultural production and waste water treatment process. The percentage of removal was doubled with a detention time of two days and argued that such reduction is related to both physical setting and plant absorption and the removal of nitrogen and phosphorus by biomass production. Among floating aquatic plants, water hyacinth has been extensively studied at the laboratory and pilot levels and evaluated on a large scale for removing organic matter from wastewater.

Fig 3.11 Water Hyacinth

3.4.1.2 Cattail (Thypalatifolia)

Thypalatifolia is a not free floating aquatic plant but its roots spread around the submerged soil. The roots will directly absorb the suspended particle present within the water sample. Cattails are typically grown between 5 and 10 feet high with a dark brown top that resembles a cat-tail. Cattail leaves are flat and twist on the plant. Cattails are ideal for large scale phytoremediation projects in wetlands and to absorb contamination from groundwater. It could also work in on a small inexpensive scale helping to reduce arsenic contamination in impoverished areas. The cattails are allowed to thrive in designated pre-treatment areas where they absorb phosphate from runoff. They have been associated with remediating sites contaminated with arsenic, pharmaceuticals and even explosives. As for a role in the global warming picture, planting cattails could help prevent excess methane emissions from degraded wetlands. Their ability to trap particles reduce the formation of caters and fissures caused by water erosion in constructed wetlands. Cattail is a natural water purifier that requires no power or plumbing, which can be assembled from materials at hand using simple instructions. Sometimes it takes a low tech solution to solve high tech problems.

Fig 3.12 Cattail

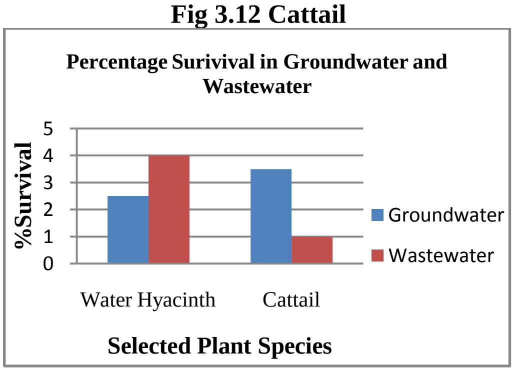


Fig 3.13 Percentage Survival in Groundwater and Wastewater

3.5 INSTALLATION OF AQUATIC PLANT ON GROUNDWATER SAMPLE

3.5.1 Experimental Setup

For planting of cattails, a glass tank of size 75cm×30cm×35cm is taken and it is filled with 30 litres of contaminated ground water sample taken from the cemetery area. Then a sand layer of depth 5cm is filled at the bottom of the tank. After filling of the sand layer, the cattails are made to stand upon the sand layer by burying the roots of cattails under the sand. This makes the cattails to stand rigid on the water. After one day, the suspended particles from the sand layer will get settled. The whole setup is placed on the sunlight. Continuous monitoring and maintenance is done on the plants.

Similarly, for water hyacinths, a bucket of height 20cm and diameter of 35cm is taken. The bucket is filled in half with the water sample for treatment process. Then the water hyacinths taken from the pond is placed on the contaminated water sample on the bucket. Similarly, the bucket is placed on the sunlight for better growth of the plants and for the better removal of pollutants from the water sample.

3.5.2 Periodic Maintenance

After installation of two different plants species on the groundwater samples, some maintenance should be done to remove the contaminants presents in it. Maintenance procedures for water hyacinth and cattail are different from each other. For better growth and better removal of contaminants from the samples, water hyacinth needs more sunlight than the cattail. So they should be kept under sunlight for fulltime. But for cattail, they should be kept under shades at noontime and under sunlight at early morning. Both the experimental setups should be prevented from rainfall in case of mixing of rainwater into the sample waters. They should be covered by nets to prevent mosquito breeding and interference of dust particles. This setup and maintenance should be made up to 35 days. For complete removal of contaminants from the sample, it may take up to several days.

For Cattail,

Fig 3.14 Before deposition of sand

Fig 3.15 After deposition of sand

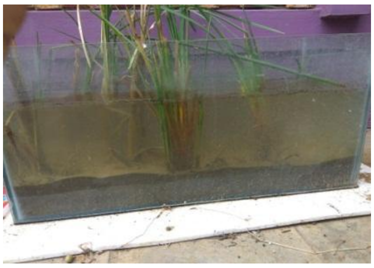


Fig 3.16 After 20 Days

Fig 3.17 After 35 Days

For Water Hyacinth,

Fig 3.18 At the time of placing

Fig 3.19 After 30 Days

3.6 FINAL TESTING OF SAMPLE

For final testing of the sample, the surface water should not be taken in case of algal formation. The water from the depth of about 5cm from the top layer is taken and given for testing, because the water from the middle layer is free from algae and dust. In order to take the middle layer water, a tube is inserted into the water without disturbing the surface and the water is sucked out. Then this water is given for final testing.

Table 3.3 Final test results

Parameters	Final Results (Water Hyacinth)	Final Results (Cattail)
Appearance	Slightly turbid	Slightly turbid
Colour(pt, co-scale)	Yellowish	Yellowish
Odour (TON)	None	None
Turbidity (NTU)	7.9	7.6
Total Dissolved Solids(mg/L)	3851	3795
Electrical Conductivity	4800	4200
pH	8.1	7.69
Alkalinity	19	13
Total Alkalinity(mg/L)	989	857
Total Hardness(mg/L)	1055	963
Calcium (mg/L)	287	257
Magnesium (mg/L)	81	79
Iron (mg/L)	0.71	0.71
Manganese (mg/L)	0	0
Free Ammonia (mg/L)	0.13	0.15
Nitrite (mg/L)	0.02	0.02
Nitrate (mg/L)	11	13
Chloride (mg/L)	1024	1008
Fluoride (mg/L)	0.97	1.2
Sulphate (mg/L)	498	510
Phosphate (mg/L)	0.2	0.1

4. TEST RESULTS AND COMPARISON

4.1 Comparison of Initial and Final Results

Both the plant species showed variation in the final results from the initial results. On the account of growth, water hyacinth showed better growth than the cattail. Cattail does not grow well on the test sample but it survived in it. The roots of cattail plant are larger and thicker than water hyacinth. So it can absorb large amount of nutrients from the water than water hyacinth. Previous journals using water hyacinth showed that it removes only heavy metal concentration. But it also showed variations in other physical and chemical parameters such as pH, total alkalinity, calcium, magnesium, nitrite, etc… In case of overall removal efficiency cattail plays a vital role. The following are the tables which show variations between raw and treated samples using water hyacinth and cattail.

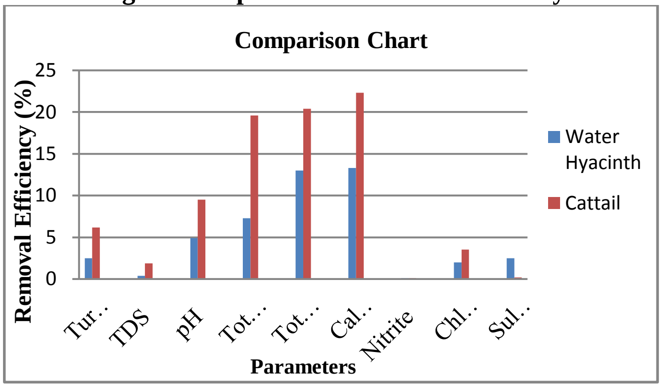
Table 4.1 Comparison between results by using water hyacinth

Parameters	Raw Sample	Treated (Using water hyacinth)	Removal Efficiency (%)
Turbidity (NTU)	8.1	7.9	2.5
Total Dissolved Solids (mg/L)	3867	3851	0.4
pH	8.5	8.1	4.9
Total Alkalinity (mg/L)	1067	989	7.3
Total Hardness (mg/L)	1211	1055	13
Calcium (mg/L)	331	287	13.3
Nitrite (mg/L)	0.02	0.02	0
Chloride (mg/L)	1045	1024	2
Sulphate (mg/L)	511	498	2.5

Table 4.2 Comparison between results by using cattail

Parameters	Raw Sample	Treated (Cattail)	Removal Efficiency (%)
Turbidity (NTU)	8.1	7.6	6.17
Total Dissolved Solids (mg/L)	3867	3795	1.86
pH	8.5	7.69	9.5
Total Alkalinity (mg/L)	1067	857	19.6
Total Hardness (mg/L)	1211	963	20.4
Calcium (mg/L)	331	257	22.3
Nitrite (mg/L)	0.02	0.02	0
Chloride (mg/L)	1045	1008	3.54
Sulphate (mg/L)	511	510	0.2

Fig 4.1 Comparison of removal efficiency



5. Conclusion

Rhizo-filtration is one new clean up concept that involves the use of plants to clean contaminated environments. This review showed that aquatic plants such as water hyacinth and cattail can have remediation effects on removal of pollutants from cemetery area groundwater. These aquatic plants uptake pollutants as plant nutrients. In this study, rural cemetery area groundwater sample has more pollutants than the urban. Both the aquatic plants showed better removal of pollutants from the cemetery groundwater sample. But water hyacinth has better growing capacity in the polluted groundwater sample than cattail. On account of removal efficiency cattail is far superior to water hyacinth.

Overall, Cattail is suggested for the better removal of pollutants from the polluted cemetery groundwater. More over these two plant species are suitable for our climatic conditions.

References

[1]. C.A. Byrne, A. Nankishore and A.A Ansari in 2015 "Wastewater Management Using an Aquatic and Semi-aquatic Plant Species, Cattail and Duckweed" published in Journal of Agriculture and Ecology Research, Vol.no. 9, pp 123.131

[2]. A.G. Fineza, E.A.G. Marques, R.K.X. Bastos, L.S. Betim in 2014 "Impacts on the Groundwater Quality Within a Cemetery Area in Southeast Brazil" published in Journal of Soils and Rocks. Vol.no.2, pp 161-169.

[3]. CorneliaJonkerandJanaOlivier in 2012 "MineralContaminationfromCemeterySoils" published in International Journal of Environmental Research and Public Health, Vol.no.9, pp 511-520.

[4]. DivyaSingh,ArchanaTiwariandRichaGupta in 2012 "Phytoremediationofleadfromwastewaterusingaquaticplants" published in Journal of Agricultural Technology, Vol.no.8, pp 1-11.

[5]. PiyushGupta,SurendraRoy,AmitB.Mahindrakar in 2012 "TreatmentofWaterUsingWaterHyacinth,WaterLettuceandVetiverGrass" published in Journal of Resources and Environment, Vol.no. 2, pp 202-215.

[6]. Robson Willians da Costa Silva, Walter MalaguttiFilho in 2011 Geoelectrical mapping of contamination in the cemeteries" published in Journal of Environmental Earth Science, Vol.no.10, pp 121-143.

[7]. Archana Dixit, Savita Dixit and C.S. Goswami in 2011 "Process and Plants for Wastewater Remediation: A Review" published in Scientific Reviews and Chemical Communications.

[8]. L.L. Behrends in 2007 "Useofaquaticplantsforremovalofnitrate-nitrogeninsubsurfaceflowconstructedwetlands" published in Journal of Reciprocating Water Technologies, Vol.no 1, pp 105-127.

[9]. Gideon Tredoux, Lisa Cavé and PannieEngelbrecht in 2004 "Groundwater Pollution : Are we monitoring appropriate parameters?" published in Water Institute of South Africa, Vol.30 no.5, pp 114-119.