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SYSTEMATIC REVIEW ON CONSTRUCTED WETLAND FOR REMOVAL OF NUTRIENT FROM WASTE WATER

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Authors SK, MA and FUR are the mains author of the research. All other authors have equally contributed in literature collection and editing of the review. All authors read and approved the final manuscript.

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Systematic Review Article

ABSTRACT

Creation of wetlands have been good constituted as impressive and sustainable liquids to the problem aquatic nutrient enrichment. They are environmentally-friendly and a biologically sustainable choice for water contamination management. The objective of the studies was to conducting systematic reviews on creation of wetland for discharge of nutrients (phosphorus and nitrogen). To point out the removal of nutrients using constructed wetland a systematized assessment of literary study was conducted. Four web page were searched with keyword from practicing a search scheme that was modified supported on the technological demand of each particular database. Out of 86 articles downloaded 10 were included the reviewed per inclusion criteria's. The result showed that total phosphorous removed using different type of constructed wetland were 71% (SSF), 90.32% (VBF), 93.9% (HBF), 95.3% (hybrid baffle flow), 94% (constructed wetland using selected plant species) & 64% (hybrid constructed wetland). In addition to theses Ammonium Nitrogen and Total Nitrogen were significantly removed, Ammonium Nitrogen 86% (FWS), 98% (SSF), 83.9% (VBF), 92.7% (HBF), 94.7% (Hybrid Baffle Flow), 60%(Constructed Wetland with selected plant species), 83% (Hybrid Constructed Wetland), 92.8% (Constructed Wetland with selected plant species) & 88.8% (Hybrid Constructed Wetland) and total nitrogen were 95% (FWS), 98% (SSF), 56.25% (HBF), 61.67% (Hybrid Baffle Flow), 83% (Hybrid Constructed Wetland), 64.7% (Vertical flow constructed wetland with substrate CBAD, MSAS), 90.7% (Constructed Wetland with selected plant species) & 79.9% (Hybrid constructed wetland). In general the TP, TN & NH3-N, were removed significantly using different type constructed wetland.

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ACRONOMYS

BOD–Biochemical Oxygen Demand; COD–Chemical Oxygen demand; NH_3-N–Ammonium Nitrogen; TN–Total Nitrogen; TP–Total phosphorous; SSF–Subsurface Flow; CW–Constructed Wetland; FWS–Flow Water Surface; HLR–Hydraulic Loading Rate; CMD–Centimeter Per Day; RT–Retention Time; VBF–Vertical Baffle Flow; HBF–Horizontal Baffle Flow.

1. BACKGROUND

Creation of wetlands are in ordinary use in numerous parts of the world and supply a comparatively economic and expeditious polishing move and a crucial extra obstacle to impurity in waste water [1]. They are environmentally-friendly and an environmentally sustainable choice for water impurity managements. Natural wetlands are biologically different scheme Almost of these processes are expedited by the wetland vegetation, connected biofilms and micro-organisms. Wetland ecosystems are congested and the physical phenomenon between a organic phenomenon and biotic components are important to knowing of the treatment processes. These are ways for mariculture wastewater cleaning. The hydraulic regime is a central part in the effectiveness of sub-surface flow CW treatment [2,3]. It is a easy, cheap attention alternative, have been practiced to treat housing wastewater for small gathering. Although displaying outstanding promise for excluding carbonaceous material from waste water, wetland systems have not been successful in excluding nitrogen principally due to shortage of dissolved oxygen [4].

Constructed treatment wetlands have been good established as efficacious and sustainable solutions to the problem of urban water treatment and reuse [5]. It is a cost-effective component of a comprehensive scheme for small-scale nutrient reduction and water quality modification for surface water bodies [6]. construction of wetlands have germinate into a reliable wastewater treatment technology for different sort of effluent. The categorization of construction of wetlands is settled on: the vegetation form (emergent, submerged, floating leaved, free-floating); hydrology (free water surface and subsurface flow); and subsurface flow wetlands can be further categorized accordant to the rate of flow direction (vertical or horizontal) [7].

Vertical flow construction of wetlands take away successfully ammonia-N but very limited de nitrification takes place in these plan of action. Otherwise, horizontal-flow construction of wetlands supply better circumstances for de nitrification but the power of these system to nitrify ammonia is very narrow [8]. In order to accomplish best handling operation, viz. for nitrogen, several kind of construction of wetlands could be united into hybrid group [7]. It incorporate VSSF and HSSF in ordering are feasible secondary for wastewater treatment for tiny source of pollution particularly when living things, ammonia and phosphates are the handling mark [9]. It execute numerous uses that are advantageous to both humans and wildlife. One of the most crucial is water filtration. As water flows through with a Wetland, it slows down and some of the suspended solids become treed by vegetation and settled out. Other waste matter are changed to less soluble forms taken up by plants or become inactive and get rid of waste product from the water. These surplus nutrients are oftentimes absorbable and change organic nitrogen into functional, artificial forms (NO_3 and NH_4) that are essential for plant development and into the gasses that running away to the atmosphere [10].

Nutrient removal efficiency of subsurface constructed wetland mean concentrations of TN and TP were decreased by 22% and 80%, respectively [11]. Effluent treatment skillfulness was increasing proportional to the extending of HRT. Vegetation in constructed wetland gave 73.37%, 77.67% and 63.64% of TKN, BOD5 and phosphate respectively with 4 day HRT (Panrare, Sohsalam and Tondee, 2015). Discharge of total phosphorus and nitrogen changed between 40 and 60% and 75 g N m^{-2} yr^{-1} and 40 and 55% with 250 and 630 g N m^{-2} yr^{-1} respectively in all ranging depending on CWs type and inflow loading [8].

1.1 Objective

1.1.1 General objective

- To Reviews Nitrogen and Phosphorous Removal efficiency of Constructed Wetland.

1.1.2 Specific objective

- To review nitrogen removal efficiency by constructed wetland.

- ❖ To review phosphorous removal efficiency by constructed wetland.
- ❖ To review method of removal of nutrients by constructed wetland.

2. METHODS

An organized review of written material was done to consider studies focusing determinants of constructed wetland for removal of nutrients discharged from different source. Three websites were searched, by handling a search scheme that was modified based on the technological demand of each website. Articles were freely screened for qualification. of the 86 articles were - screened with the title and objective of articles and finally 10 studies fulfill all the inclusion criteria.

2.1 Search Strategy

The succeeding websites were searched with PubMed, Research Gate, science direct and Google practicing a finding plane that was formulated settled on the cardinal words like constructed, wetland, waste water, pollution ,control, nutrient and removal were inserted in to known from the learning goal, which was modified accordant to the discipline demand of every special website.

2.2 Eligibility Criteria

The written report to be included under the reviews inclusion and exclusion criteria's were defined .the inclusion criteria were all type of constructed wetland, the title and objective of studied and quantitative type of studied. Whereas Excluded criteria's like natural wetland, qualitative type of studied, unlined title and objective, revewed paper, books and illegal publish document.

2.3 Review Procedure

This engaged a handbook find of reference lists of articles and reports, and other online Methods. Finding answers were foreign into the website and copy were screened for and deleted. At the start, heading were examined for connection and heading evidently not full filling the involvement standard were eliminated. And then, the viewing of abstracts of those heading that full fill the inclusion goal began, and abstracts not full filling the inclusion goal were leave out. At last, the rigorous and big judgment of the included full-text articles as they full fill the inclusion criteria was managed to reviewed in detail.

2.4 Data Abstraction

Type of wetland, removal of nutrients which is nitrogen and phosphorous compound were the key factor to extracted from the articles .detail skimming of the selected articles were done and relevant data like type of methods of removal, nutrients nitrogen and phosphorous amount removed, countries /areas of studied were taken based on the objective requirement of the review and proceed to analysis the data manually.

2.5 Data Analysis

A communicative investigation access was practiced to analyze the information. For all learning data was take out into a table make information on: (1) 1st author and publication's year; (2) chemical parameters such as phosphorous, nitrogen and other; (3) constructed wetland type (4) countries.

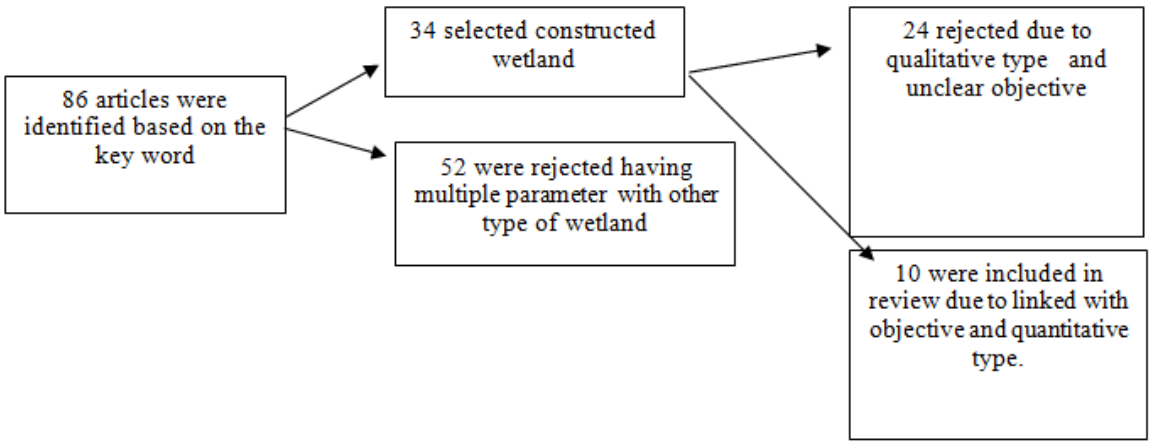

Fig. 1. Flow chart for study selection

3. RESULTS

The reviews were conducted with 10 studied papers which depicted on Tables 1 and 2. The first table shows that different countries used constructed wet Sland for the management of different waste water source. Whereas on the second table illustrate the removal efficiency nutrients' using different type of constructed wetland.

Constructed wasteland is now a day widely applicable in all the countries in the world specially in urban area which highly intensive human activities are done with emitted huge amount of wastes are discharge to the environment and makes unsighted living condition. the result of these review show in (Table 1). Based on the systematic review were found in Asia countries which used constructed wetland as remedy for pollution control.

Table 1. Following are the examples of the use of constructed wetland for various waste water source

Source of Waste	Location	Reference
Aquaculture	Taiwan	Lin et al. [12]
Domestic waste	China	Ye and Li [4]
Urban waste		Russo et al. [13]
Septic tank	China	Cui et al. [14]
Agricultural waste	China	Cui et al. [15]
-	-	Mounir et al. [16]
Domestic waste	India	Yadav, Chazarenc and Mutnuri [17]
Lagoon pretreated waste		Luo et al. [18]
Sewage	Thailand	Panrare, Sohsalam and Tondee [19]
-	-	Vymazal and Kröpfelová [20]

Table 2. Application of several type of constructed wetland with removal efficiency of nutrients

CW type	Parameter					HLR	Reference
	BOD	COD	NH3-N	TN	TP		
FWS	-	-	86%	95%	32%	1. 8 Cmd^-	Lin et al. [12]
SSF			98%	98%	71%	13.5 Cmd^-	
CW with disinfection	62.50%	62.67%	40.33%	45.33%	34.50%	-	Russo et al. [13]
V baffle flow	75.05%	62.05%	83.90%	46.85%	90.32%	1d(RT)	Cui et al. [14]
H baffle flow	91.74%	82.70%	92.75%	56.25%	93.52%		
Hybrid baffle flow	89.87%	79.32%	94.78%	61.67%	95.34%		
CW with selected plant species	90%	80%	60%	No3-(50%)	94%	-	Mounir et al. [16]
Hybrid CW	-	85%	83%	83%	64%	16-32cm/d	Ye and Li [4]
VFCW with substrate (CBAS,MSAS & BFAS)	-	-	-	64.70%	25.21%	14cm/d	Cui et al. [15]
VFCW with different hydraulic loading rate	74.75%	76.25%	44.25%	39.75%	43.50%	15-22cm/d	Yadav, Chazarenc and Mutnuri [17]
CW with selected plant spcies	-	-	92.80%	90.75%	-	-	Luo et al. [18]
CW with vegetation	77.67%	-	-	73.37%	63.64%	-	Panrare, Sohsalam and Tondee [19]
Hybrid CW	92.5%	83.8%	88.8%	79.9%	30%	-	Vymazal and Kröpfelová [20]

Key; SSF=sub-surface flow, FWS=flow water surface, CW=constructed wetland, V. baffle flow=vertical baffle flow,

H. baffle flow=horizontal baffle flow, VFCW & vertical flow constructed wetland

4. DISCUSSION

From reviewed finding Diverse kind of wetlands were united and used in order to accomplish better management efficiency, specially for nitrogen and phosphorous. Even so, hybrid systems VSSF (VF) and HSSF (HF) were most frequently used for better removal of nutrients wetland [20]. Hybrid constructed wetlands could attain better discharging of Ammonium Nitrogen due to the power of provide both aerobic and anaerobic/anoxic suition at that time [9]. In the single type of constructed wetland like subsurface flow remove 71% , 86%, 95 % of total phosphorous ,ammonium nitrogen and total nitrogen respectively which is better removal efficiency on total nitrogen [12] but controversially other studies [11]. Total phosphorous removal using hybrid constructed wetland with selected plant species and hybrid constructed wetland without planted species but with substrate were 94% and 64% respectively, which is better removal efficiency on hybrid with selected plant species, similar to [21].

4.1 Nitrogen Removal

Nitrogen can be removed by denitrification and nitrification of NH_3-N, NO_2 & NH_3 compound by the agent of nitrifying bacteria. It is also one of the components of nutrients which is found in different source of waste water. when it entered in to the water body result significant adverse health effects on water body and aquatic organisms due to nitrification and algal bloom. Therefore, protections them through application of constructed wetland. In this reviewed two type of Nitrogen compound such as NH_3-N & Total Nitrogen removed efficiently by using different type of constructed wetland.

4.2 Ammonium Nitrogen Removal

Ammonium Nitrogen were removed 86% & 98% by using FWS and SSF respectively [12]. Constructed wetland with pre disinfection of waste water remove 40.3% [13], using vertical baffle, horizontal baffle and hybrid baffle remove 83.9%, 92.7% & 94.7% respectively as studied by [14], hybrid constructed wetland also remove 83% [4], vertical flow constructed wetland with different hydraulic loading rate were used to remove 44.3% [17], Constructed wetland with selected plant species were used to remove 92.8% [18] which has similar efficiency done by [14], using horizontal baffle flow. In general the removal of NH_3-N is found in higher efficiency of removal using hybrid baffle flow (94.7%) [14] and low efficiency were seen using constructed wetland with pre-disinfection of waste water by [13].

4.3 Total Nitrogen Removal

Based on the reviewed data Total Nitrogen were removed variously and significantly using different type constructed wetland using FWS and SSF remove 95 % and 98% respectively according to [12], 45.33% were removed by constructed wetland with pre-disinfection of waste water [13], use of different baffle flow like vertical, horizontal, hybrid type remove 46%, 56% & 61.7% respectively as studied by [14], hybrid constructed wetland remove 83% [4], vertical flow constructed wetland with used substrate (CBAS, MSAS & BFAS) in average remove 64.7% [15], use of vertical constructed wetland with different hydraulic loading rate remove 39.75% which is low efficiency as compare with other type constructed wetland [17], constructed wetland with selected plant species remove 90.75% [18], constructed wetland with vegetation remove 73.37% [19], hybrid constructed wetland remove 79.9% as studied [20]. In general among reviewed the highest removal efficiency of Total Nitrogen were by FWS & SSF which is 95% 98% respectively [12] whereas low removal efficiency on vertical flow constructed wetland with different hydraulic loading rate (15-22cm/d) 39.75% [17].

4.4 Total Phosphorous Removal

Phosphorous is one of the components of nutrient chemical that can be found in different waste water .according to the reviewed paper different studies were conduct to remove total phosphorous using varieties of constructed wetland with different efficiency (Table 2). Different baffle flow were used to remove total phosphorous from waste water. The according to result of reviewed paper vertical, horizontal & hybrid type of baffle flow remove 90.3%, 93.5% & 95% respectively [14], constructed wetland with selected plant species remove 94% [16], hybrid constructed wetland remove 64% [4], constructed wetland with vegetation can remove 63.6% [19] less than 50% removal efficiency were seen using hybrid constructed wetland 30% [20], vertical constructed wetland with different hydraulic loading rate 43.5% [17] vertical constructed wetland with different substrate (CBAS, MSAS & BFAS) in average remove 25.25% [15], constructed wetland with disinfection of waste water can remove 34.5% [13] and 32% was removed using constructed wetland with Flow water surface [12]. In general high removal efficiency were recorded by

using hybrid baffle flow constructed wetland which is 95% [14].

4.5 BOD and COD Removal

Biochemical oxygen need and chemical oxygen need also another indicator of the extent of pollution of waste water .when this waste enter in to the water body it has significant impact on water quality and aquatic organisms. Therefore removing this pollutant is important to protect the aquatic life and improve water quality with constructed wetland .according to the reviewed paper constructed wetland with selected plant species remove 90% & 88% of BOD & COD respectively [7]. In general all type of constructed wetland under reviewed in this paper remove more than 50% of BOD & COD contents of waste water.

5. LIMITATION

Many of the studies were done throughout the world but most of them used as experiment to assess the removal efficiency of plant species, media, substrate, associated with different loading rate, retention time, and some of them also used different parameter which is not important for this review. In addition to these there were small in number of research were done in Ethiopia context and methods used for removal of nutrient were different some studies and so on. problems make weak the reviews to pool the result finding together.

6. CONCLUSION

Constructed wetland is the simplest and eco- friendly ways of water treatment and pollution control strategy. It effectively remove significant amount of nutrients such as nitrogen and phosphorous through absorption, degradation, denitrification, nitrification process using different type of constructed wetland.

7. RECOMMENDATION

Based on the review result and real figures of our countries for the policy makers, the researchers, land and water management authority, governmental and none governmental institution (university, collages, Industries, factories and etc) recommend:

- To use different type of constructed wetland type to remove nutrients, BOD, COD and other pollutant rather than discharging waste and pollute the water body.
- Researcher conduct investigation on the discharged point pollution and extent of pollution of environment with sustainable solution.
- Policy makers formulate rule and regulation on pollution and enforce them.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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