# Improvement of water ecological restoration plants on drinking water source

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**Abstract:** The improvement of water ecological restoration plants on drinking water sources is researched. The water ecological restoration plants is an important part of aquatic ecosystems, and capable of improving contamination of drinking water sources effectively and enhance the water quality of drinking water sources. The pathway used by water ecological restoration plants to restore drinking water source mainly include physical processes, absorption, is closely related to synergistic and allelopathic effects, the whole process of ecological restoration is related to environmental factors like light and temperature closely. This paper reviews the repair process and pathways of water ecological restoration plants on drinking water sources. Water ecological restoration plants, located between all interfaces of ecosystem of drinking water sources, capable of removing nitrogen and phosphorus, adsorbing heavy metals in drinking water sources, and playing a regulatory role in stabling and cycling of drinking water sources ecosystems.

## 1 Introduction

The ecosystem of drinking water source is a diverse group surviving by water, and plays an important role in maintaining global material recycle and water cycle [1]. With the continued increasing of water consumption, as well as increasingly serious disturbance to the ecosystem of drinking water sources caused by people, China drinking water source ecosystem has been severely damaged [2]. Fertilizers, pesticides, sewage and industrial waste has polluted many water bodies, leading to water quality decline [3]. So far, there is no single biological, chemical and physical methods can better control the eutrophication of water bodies, the reason lies in the complexity of pollution and high difficulty of nutrient removal [4].

Ecosystem restoration of drinking water sources is through a series of protective measures to slow down the degradation of drinking water sources ecosystem to maximum, and restore or repair degraded ecosystem to an acceptable, long-term self-sustaining, stable state. With the constant improvement of drinking water sources ecological restoration theory, techniques developed for the ecological restoration of drinking water sources have continued to be mature [5,6]. In order to accelerate the restoration of damaged ecosystems of drinking water sources, in addition to relying on the self-adaptive, self-organizing, self-regulating to repair, also by some auxiliary artificial measures to serve for the healthy functioning of ecosystem. Usually the process includes that reconstructing physical environmental conditions before interference, regulating chemical conditions of water and soil environment, reduce environmental pressures of ecosystems. In situ process utilizes bioremediation or biological control, as far as possible to protect the constituent part which is not degraded yet in drinking water sources ecosystem.

## 2 the relevant principles of improvement of water ecological restoration plants on drinking water sources

Water ecological restoration plant is an important means to improve drinking water sources. On the one hand water ecological restoration plant can absorb part of nutrients by itself, while its root zone provide the necessary places and aerobic conditions for survival and degradation of nutrients of microorganism. The roots of water ecological restoration plant often form a network-like

 

structure, roots in the network not only adsorb and settle nutrients like nitrogen and phosphorus in drinking water, but also provides a good biochemical criteria for the absorption and metabolism of microorganisms.

Self-absorption of water ecological restoration plant is one of the main mechanisms for the removal of nitrogen and phosphorus in drinking water sources. The nutrients absorbed by water ecological restoration plants are retained in the plant basically during its growth process, it can be said that water ecological restoration plant is a nutrition repository. These plants can be harvested, so as to move nutrients out of the drinking water sources ecosystem.

The productivity of water ecological restoration plant depends on nutrition available for being used, environment and its adaptability to the environment. The slender leaves of water ecological restoration plants, both ensures a large leaf area, but also reduces the block between the blades, forming a suitable microclimate, thereby promoting photosynthesis.

One important function of water ecological restoration plants is secreting oxygen, which is to deliver the oxygen released by photosynthesis of leaves floating on the water through branches to the roots. Thus, the soil contact with the stem and roots directly is different from the soil around other parts, showing the aerobic condition. These oxygen utilized to maintain activity of aerobic microbial existing at the center and around of the root zone.

In addition, roots, stems and root hairs of aquatic plants can form more effective current in drinking water sources, so that it can contact with the end of filler better. The underwater part and the damaged leaves of these plants plays an important role, which provide habitat place for microorganisms in the water to grow; in addition, branches and leaves above the water forms the shadow, limiting the transmission of light, thereby blocking growth of algae. There are many species of water ecological restoration plant can be used for drinking water sources, reed, rushes, cattails and sedges are common. The key to select the appropriate species of water ecological restoration plant is a dense root system and a strong ability to secrete oxygen.

## 3 the principle of estimation methods for the improvement of water ecological restoration plants on drinking water sources

A variety of group competition mechanism are introduced in the immune algorithm, which can estimate the improvement degree of water ecological restoration plants on drinking water resources. Its details are as follows:

After the introduction of a variety of group competition mechanism, it can be divided of into relative adaptation and absolute adaptation according to their fitness. The following equation can be used to express absolute adaptability factor:

$$hw^{c}(R) = h(f^{-1}(R)) \tag{1}$$

After the introduction of a variety of group competition mechanism, the competition times of the group determines the relative adaptation factor of improvement degree of drinking water resources.

Population composed by characteristics of improvement degree of drinking water sources expressed by the following formula:

$$C = \{C_1, C_2, \cdots, C_p\} \tag{2}$$

Evaluation of the population represented by the following formula:

$$D = \{D_1, D_2, \cdots, D_q\} \tag{3}$$

Estimated results of the improvement degree of water ecological restoration plants on drinking water sources with a variety of group's competition mechanism can be obtained by the following formula:

$$hv'(C_k) = (\sum_{l=\Omega_l} \frac{1}{V_l}, \forall l \in \Omega_l \subseteq [1,q], h(f^{-1}(C_k)) < \qquad h(h^{-1}(C_l)))$$

$$V_l = (\sum_{n \in \Omega_k} 1, \forall n \in \Omega_k \subseteq [1,p], h(f^{-1}(C_n)) <$$

$$h(f^{-1}(D_l)), D_l \in D) \quad (4)$$

According to the above formula, it can be indicated that adaptation of groups is proportional to the number of evaluation times.

The competition populations introduced during the evaluation process of improvement degree of drinking water sources, includes two, one is learning populations, and another one is evaluating populations. Relative adaptability factor may represent two populations.

Initialized characteristics population formula is set as follows:

$$C(0) = \{C_1(0), C_2(0), \cdots, C_p(0)\}$$
$$D(0) = \{D_1(0), D_2(0), \cdots, D_q(0)\}$$
$$T(0) = \{T_1(0), T_2(0), \cdots, T_m(0)\} \quad (5)$$

In the formula, $C$ is the learning population existing during the improvement estimation process of water ecological restoration plants on drinking water sources, $D$ is another corresponding evaluation population, $m \leftarrow 0$.

Assuming in the estimation process of improvement of water ecological restoration plants on drinking water sources, the immune vaccine represented by $V_g$, according to the above three improved results to estimate the absolute adaptation factor of multi-populations calculation, the optimal results can be acquired, and the optimal result is regarded as immune vaccines of competition populations, the formula is as follows:

$$h(f^{-1}(X(m))) = V_g(C(m), D(m), T(m)) = \max\{h(f^{-1}(C(m))),$$
$$h(f^{-1}(D(m))), h(f^{-1}(T(m)))\} \quad (6)$$

Through the above formula, the optimal results for introducing immune algorithm into various populations competition mechanism may be obtained, and accumulate multiple optimal results, it is possible to get the optimal result of estimated improvements of water ecological restoration plant on drinking water sources.

## 4 System Simulation Research

In order to verify the effectiveness of improvement of the proposed water ecological restoration plants on drinking water sources, a simulation experiment is conducted. In the experiment, water quality of 90 samples of a reservoir used as drinking water source from 2010 to 2013 are selected to research and analyze. No. 1-80 samples are the known data in this experiment, No. 81-90 samples are data for testing. According to the data to estimate the improvement results of water ecological restoration plants on drinking water sources at 2014, and the final results were compared to the last ten samples.

The 80 groups of water quality from 2010 to 2013 are regarded as data training samples, represented by the following table:

**Table 1 training sample data**

| Sample No. | Time | Water turbidity |
|---|---|---|
| 1-10 | 201005 | 33 |
| 11-20 | 201005 | 31 |
| 21-30 | 201101 | 29 |
| 31-40 | 201101 | 28 |
| 41-50 | 201201 | 25 |
| 51-60 | 201201 | 22 |
| 61-70 | 201305 | 19 |
| 71-80 | 201305 | 18 |

Through the experiments results of water ecological restoration plants on drinking water sources, we can see that from 2010 to 2013, under the function of water ecological restoration plants, the water quality of drinking water sources has been significantly upgrade.

## 5 Conclusions

Using water ecological restoration plants improve the water quality of drinking water sources, can greatly enhance the water quality of drinking water sources to meet the demand for drinking water in life. In the case of drinking water continues to decrease, the improvement of drinking water quality has reached a degree of urgency, therefore, the water ecological restoration plant used for improving drinking water sources plays a great role, and has broad prospects and good space for development.

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