

Hydrological Research Progress in Forest Marsh Ecosystem

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Abstract—Forest swamp has important hydrological support functions, including providing water storage space, adjusting and saving the flood peak, keeping the underground water level, recharging runoff, taking the degradation of pollution and purifying water quality, etc. This paper summarizes the current progress of forest swamp hydrology research and the forest swamp hydrology dynamic response to human activities. Finally, the paper put forward the suggestions for restoration and protection of forest swamp.

Keywords—Forest swamp; Water conservation; Hydrological dynamics

I. INTRODUCTION

FRESHWATER forest swamp is the long-term or periodic flooding of freshwater woody community, it includes freshwater swamp, beaches hardwood forest, riverside forest buffer, etc ^[1]. The formation of forest swamp needs specific climate and physiognomy conditions. To ensure that it's too wet environment and the plant residues input speed is greater than the decomposition speed ^[2]. The formation of freshwater forest swamp mainly through two ways, is positive succession and reverse succession. Positive succession is swamp areas dry, mainly displays in the water level drops, large vascular plants into swamps, reinforce the evaporation and scattering and exacerbate the process of dry. Eventually, through succession form the forest marsh ecosystems. Reverse succession is that process, Freshwater forest swamp is beginning as forest, but it's environment with geological changes and climate change becoming more moist, the ground accumulated water for a long time and the vegetation succession turn to the succession of wet. It above said is swamping the forest. Anaerobic environment formed by surface water blocking the decomposition of plant residues and forming the peat accumulation, eventually form the forest swamp ^[2, 3]. The density of trees in the forest swamp generally low, and the peat layer are thinner because the forest swamp is too wet, and the air permeability is very poor, this serious impact on the growth of

tree root, so the trees grow in the environment have the lower productivity than the trees grow in forest, and have the relatively sparse vegetation density^[4]. Shrubs, mainly grows in the moss mound. The moss mound is formed by moss accumulation, it builds relatively dry patches in the forest swamp water environment and provides the germination and survival conditions for shrubs. Herbs mostly hygrophilous plant groups, because the forest canopy's cover makes the population density and biomass are less than the same plant in the surrounding swamp areas.

Forest swamp have both tall trees and peat layer in forest ecosystem and marsh ecosystem, so the hydrological function of forest marsh ecosystems can be defined from the dual attributes of swamps and forests. It is embodied in the process of redistribution of water input by the interception by forest canopy, the catchment by ground surface depressions, peat layer to store water and runoff. Hydrological support functions of forest marsh ecosystem performance for hydrological function of forest ecosystem from the short time scale. It is mainly reflected in the interception capacity of rainfall in the layers of vegetation. In the long time scales it embodied in the hydrological features of marsh ecosystems, such as, support animal and plant growth survival, adjust the micro climate by evaporation, moisture retention and purifying water quality function, and so on^[5]. The peat layer of marsh ecosystems has good ability of water saving, this is the main reason of the existence of marsh ecosystem water conservation function. Forest swamp can intercept and subsistence precipitation in peat layer to provides the ability of flood peak for nearby rivers flow during the flood; it can supply the moisture stored to the river flow, increase the low water flow, and maintain the surrounding areas of groundwater water level in the dry season; water and vegetation in the forest swamp can adjust the micro climate through evaporation; Wet environment provided by the catchment area can also have the effect of degradation of pollutants; In addition, the complex environment of forest swamp offers living environment for a lot of animals and plants, the forest swamp protect biodiversity and maintain the biological gene pool of the swamp.

II. EFFECTS OF CLIMATE CHANGE ON FOREST SWAMP HYDROLOGY

On a global scale, the impact of climate change along with the change of regional. The Nordic forest swamp area is mainly reflected on the hydrological changes, such as the increases of annual average temperature, the distribution changes of precipitation in one year, the spring snow melt period in

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advance.

Forest marsh's peat layer is a huge carbon stock, it plays an important role on global scale carbon cycle process [6]. Climate warming increased tree growth rate [7]. At the same time it has influence on the total organic carbon concentration.

Forest swamp water temperature rise caused by climate change, organic matter decomposition rate is accelerated in the peat layer, dissolved organic carbon into the water, and thus for, the concentration of total organic carbon is to be moved up. Decomposition of organic matter product carbon dioxide, methane and other greenhouse gases at the same time, this process makes the peat layer into carbon source, and increased emissions of greenhouse gas. Climate change caused different influence to different parts of the swamp hydrology, if the rise of temperature is not obvious and precipitation increased significantly, more water catchment into forest swamp area, it take the higher marsh water level, peat layer anaerobic aggravating, also with the decrease of plant productivity and plant productivity decline [8]. For the area which temperature rise clear and precipitation will increase relatively not obvious, the runoff swamp water levels fall and vegetation productivity increases [6]. Melting snow provides the original water supply for the forest swamp after freezing period. The snow melt period in advance or delay caused by climate change will impact for phenology, such as plant germination.

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III. THE INFLUENCE OF HUMAN FACTORS FOR FOREST SWAMP HYDROLOGY DYNAMIC

3.1 THE IMPACT OF AGRICULTURAL PRODUCTION

To sustain a stable water supply capacity of water conservation forest swamp for agricultural production in the surrounding area. But the surrounding agricultural production for the forest swamp hydrologic dynamic caused great impact. Runoff of agricultural production in fertilizer by rainfall which can be discharged into the forest swamp. The input is not generally increased the biomass of fertilizer, all plants on the contrary, nutrients, nitrogen and phosphorus ratio change into forest and swamp in water, different plants with suitable proportion of different nitrogen and phosphorus growth, nutrient rich input will therefore change the interspecific competition relations within the swamp forest, species richness is reduced, cause plant community composition and dominant species of ecological characteristics of change.

3.2 INFLUENCE OF WATER PROJECTS

The water conservancy project of Forest swamp mainly refers to the drainage works. Drainage project is aimed at the status of low forest swamp tree productivity, forest swamp water level will drop, the air permeability will be increased and the trees growing conditions will be Improved through drainage to increase forest swamp tree productivity [9].

Drainage engineering will cause water levels fall which will cause a series of hydrological changes, including

influencing forest swamp hydrology, affecting aquatic habitats, intensifying hydrological fluctuations, decreasing peat porosity, reducing penetration rate. Penetration rate mainly related to peat gap. Water levels fall makes the fiber material in plant residues turning into the amorphous state of peat through aerobic decomposition, which reduces the peat layer porosity[6], increases the surface layer of density matrix.

The decrease of forest swamp water level and rainfall can wash the surface of forest swamp which makes water ion soluble in water easy to run off by leaching[10]. Forest swamp drainage can accelerate the decomposition rate of organic matter in the peat layer, which turn nitrogen and phosphorus in the peat layer into eutrophication pollutants and bleed out, and it can also increase the content of the water polluted substances in forest swamp water.

The digging of escape canal makes the peat layer damaged and the mineral layer close to even exposed on the surface may cause water acidification. In addition, Low PH can also lead heavy metal ion concentration to rise, polluting the water quality.

3.3 EFFECTS OF FOREST MANAGEMENT

Forest swamp forest management mainly refers to the logging timber resources in the forest marsh. Cut way including the selective logging, local logging and clear cutting and so on [11]. Do not only gain economic benefits, also control the forest swamp dry. Through the trees cut down to break off the forest swamp succession process, makes the swamp ecosystems degeneration. The influence of trees cut down for the forest swamp hydrological process mainly reflected in the change of forest swamp water depth, the change of groundwater level and the change of swamp water yield, water quality changes, etc.

According to the reasonable ways for logging will not impact on hydrological dynamics on a long-term scale, but within short time scales generally appear swamp water level rise. This is because the lower transpiration and the lower canopy interception amount caused by the trees reduce [12]. But from a long-term perspective, the trees cut down in the forest swamp will lead to forest swamp water levels fall at last.

Deforestation makes the nitrogen originally should be absorbed by the plants be concentration in soil. These nitrogen, in part to move deep in the soil through leaching, the other parts into the water with the rains washed out, it changes the C/N ratio which in the forest, peat swamp and water. So affect forest swamp plant growth, especially the growth of moss plants [13].

Nitrogen and phosphorus pollutants in the water can cause the eutrophication of water bodies and water blooms. Nitrogen and phosphorus pollutants makes the dissolved oxygen content in water has fallen sharply, the water damage and serious effects on forest swamp downstream water quality [13].

3.4 IMPACT ON INDUSTRIAL PRODUCTION

Since modern industrialization, the effects of human activity on environment cannot be ignored, the emissions of industrial production leads to enhanced atmospheric nitrogen deposition; Sulfate into rain lead to acid rain and carry metal ions of trace concentrations of industrialization; Emissions of greenhouse gases has led to an increased environmental

warming regional precipitation change [9].Metal elements and acid alkali change leads to the forest marsh aquatic environment change and the survival of aquatic animals in the river in the basin is in pressure; The settlement of ammonia nitrogen increased forest swamp of nutrition, interfere with the balance of nitrogen cycling in a region too.

IV. FUTURE RESEARCH ON FOREST MARSH

Future forest swamp studies will continue to further its hydrological function ^[14] the mechanism and process of research, such as precipitation confluence forest swamp hydrology dynamic process for coupling analysis. To the impact of engineering in the forestry production and to evaluate the environmental impact of forests and swamps for future environmental change to the response and recovery, the succession of forest swamp process aspects will serve as a research focus in the future for further analysis.

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