

What's New in Wetland Hydrology

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WETLAND HYDROLOGY is a new and unique field of study in watershed management research. Watershed management needs are generally associated with dry soil conditions or mountain areas where water is either a limited resource or a flood producer, rather than with level areas where soils are saturated much of the time. Yet new research in wetland hydrology in the Lake States and in the Southeast has shown the need for knowledge about water relationships in saturated areas too. The key to research needs in these areas is lack of knowledge—about the interrelationships between water management and timber production, and the influence of these practices on soil productivity, water yield, and ground water recharge. Recent studies in this field are beginning to yield important information about such relationships.

Wetland Forests and Their Use

Extensive areas of wetlands of commercial forest importance are found

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in the Southeast, Lake States, Canada, Alaska, and the Deep South, along with lesser areas in New England and elsewhere. Some 20 million acres of these lands exist along the southeastern Coastal Plain, while wet organic soils cover an estimated 15 million acres in the northern Lake States, most of which are forested. The forests vary from oak-gum-cypress woods and pine lands in the South to extensive tracts of pure black spruce stands in the North. Wet flats, upland and coastal bays, stream bottoms, glacial lake beds, and filled-in lakes represent typical sites, which vary widely in hydrologic and soil characteristics.

Water has been an important influence on the past and present history of forested wetlands. Whether the soils have been formed from alluvial deposits, marine sediments, or organic plant remains, they generally represent complex layered soils with a wide range in profile characteristics. Less is known about the physical and hydrologic properties of wetland soils than about upland soils. Some are covered with water only seasonally, while others remain saturated most of the year. Some produce large numbers of forest species, while others are nonproductive in their present state.

However, they all share one common characteristic—saturation for prolonged periods of time.

Use of the wetland forests depends upon fertility of the sites, ease of land and water management, and landowner objectives. Presently, a large acreage of the wetland forest is owned by wood-using industries, various government agencies, or others where long-term management objectives are oriented towards forestry. Timber production is now, and no doubt will continue to be, a dominant use. Additional uses may be concerned with recreation, wildlife production, and conservation and management of the valuable water resource. However, because forestry is most important now, one of the prime objectives of wetland forest owners is to increase forest site productivity. Consequently, drainage or water control practices have received considerable attention.

Water management measures are already in widespread use throughout the southeastern Coastal Plain where an estimated 1 to 2 million acres of wetland forest have been ditched to date; and the end is nowhere in sight (Fig. 1). A typical forest industry operation might involve construction of about 25 miles of main ditches and

laterals on 10,000 acres each year. In the north, both public and private interests are also interested in peat-land drainage. However, there is little scientific knowledge on water requirements of the timber to be grown, on the hydrology of various wetland types, or on soil properties affecting drainage in either northern or southern types. Too often the pattern and intensity of drainage are determined by need for accessibility rather than by a systematic evaluation of the intensity of drainage required to improve soil for timber production.

Wetland areas are being used for other purposes too. Water is generally the key to many recreation activities, and wetlands are often the headwaters for streams and lakes. Thus, changes in streamflow caused by wetland management may affect downstream recreation. Wildlife and waterfowl are also produced on some wetland forests. In both the northern breeding grounds and southern overwintering areas, waterfowl managers have been experimenting with flooding of wet areas for duck production. Wildlife habitat and biological research is now attempting to determine suitable water control techniques to increase wildlife productivity of the wetland forest. However, in this field as in timber production, effects of widespread drainage or impoundment on wetland soils and hydrology are not completely known.

And, of course, water itself is a key product from these areas. In recent years even the public in more humid eastern regions has become con-

vinced of the importance of water supply and water regulation. Now the public and industry are turning towards headwaters wetlands and speculating about their future use as water storage areas and their influence on streamflow regulation.

Thus, people have always had some use for wetland forest areas, they are presently being used, and more use is certainly planned for these lands. Yet our knowledge of the effects of land uses on the physical and hydrologic characteristics of wetlands is definitely minimal.

Present Research Efforts

Research in wetland hydrology is proceeding along several major fronts in the Southeast and Lake States. One involves study of the water balance and general hydrology of selected wetland watersheds. To do this, small watersheds have been completely instrumented with weather stations, precipitation gauges, ground water wells, and weirs and flumes (Fig. 2). This instrumentation is designed to study the general hydrologic characteristics of experimental wetlands and their surrounding area—how much water falls on them, how much runs off, and how much is lost through evapotranspiration.

In addition, these studies are supplying hydrologic data needed to design ditches and control structures with sufficient capacity to handle peak flows, to guide downstream improvement of channels that serve as primary outlets for large drainage systems, and to determine where special im-

poundments might be needed to increase ground water levels and soil moisture supplies. They also serve as calibrated watersheds for future timber stand and water regulation treatments. Such instrumentation is now supplying some of the first streamflow information available from small forested wetlands in the Southeast and Lake States.

A second major phase of wetland research is concerned with physical and hydrologic properties of various wetland soils. What little past research has been done on these soils has generally been oriented towards the agricultural aspects of soil chemistry and fertility. Yet to fully understand wetland forests as watersheds, and to evaluate their water management capabilities, it is necessary to study their physical properties. For, just as in an upland area, the soil in a wetland watershed is the reservoir where water is stored. The different physical and hydrologic properties of this soil determine its storage characteristics and its amenability to drainage. Thus, storage capacity will influence water table fluctuations and the amount of water retained after drainage. And hydraulic conductivities, both vertical and horizontal, will help determine amount and timing of outflow from wetland areas.

Laboratory and field studies have been concerned with water retention at various tensions and with hydraulic conductivity. In the laboratory, standard pressure membrane equipment has been adapted for use with peat soils, and in the field, piezometers, tubes,



Above:

FIG. 1.—This upland bay in South Carolina once produced only scattered slow-growing pond pine (right rear) and cypress. Controlled drainage has converted the area to a productive loblolly pine forest.

Right:

FIG. 2.—A recording well measuring daily ground water fluctuations in a black spruce bog in northern Minnesota.



and auger holes have been used to measure rates of water movement. These values are needed for use in flow equations and to evaluate the extent of water movement by capillary action and in the vapor phase. This early research has provided information required to plan additional specialized studies of evapotranspiration and drainage of wetland soils.

A third phase of research is oriented towards development of effective water control practices to improve productivity of wetland forest soils and evaluation of the effects of such practices on wetland hydrology. Measurements are designed to relate the rate of water table drawdown to physical characteristics of the drainage system, such as ditch depth and spacing, and to soil properties affecting drainage. In addition, changes in relationships between certain soil, hydrologic, plant, and subsurface characteristics are followed on representative sites to define their hydrology and determine effects of drainage on soil productivity. Basic streamflow and water level information collected on experimental watersheds will also be used in this program. Eventually, drainage practices on one or more small wetland areas will be evaluated, using the calibrated watershed approach.

Another phase of research is concerned with the hydrologic classification of wetlands. Wetlands vary greatly in size, depth, geologic origin, soil type, and physical and hydrologic behavior. Present classification schemes for these areas are based on ecological or morphological soil characteristics. From a watershed manager's viewpoint, it is necessary to have a classification scheme based on physical and hydrologic characteristics. Such a scheme would prove invaluable for planning drainage, cutting methods, conversion, or water impoundments. Work on this type of classification has recently been initiated.

Some Early Watershed Management Implications

Although watershed management research in wetland forests is relatively

new in the United States, early study results have pointed to some rather broad watershed implications and have helped researchers plan future study programs.

For example, it is already apparent that water management practices to improve the productivity of southeastern Coastal Plain wetlands must be based upon: (1) Hydrologic characteristics of the area, (2) soil characteristics that affect the water management system and in return are affected by it, and (3) requirements of the plants to be grown. The first two points can be demonstrated by examination of the physiography and peat soils of coastal and upland bays in North Carolina. The two types of bays are quite similar in many respects. Yet the distinction between them is important inasmuch as lack of fall of outlets and tidal effects limit the depth of drainage in coastal bays much more than in upland bays. Moreover, salt water intrusion as peats subside after drainage is a serious problem on coastal sites. On the other hand, some landowners encourage subsidence of shallow, organic soils in upland bays by deep drainage in order to increase agricultural acreage. Soils altered similarly, which have come into pine, show remarkable productivity.

Recent study results also demonstrate how widely water requirements of plants can vary. First-year survival and growth data for baldcypress and water tupelo planted on drained wetland sites indicate that these species require flooded or near flooded conditions for best early development, while loblolly pine and sweetgum on these same plots do best when water levels are at their lowest point. Consequently, water management practices must be tailored to fit particular kinds of trees, as well as wetland hydrology and soils.

Several years of records from small bog watersheds in the Lake States have provided information on annual fluctuations of the water table, precipitation-water table relationships, and water yield from natural bog areas.

These early records indicate that, because of variation in physical characteristics, all wetlands do not supply unlimited storage. Neither are all northern wetlands good regulators of streamflow over the entire year. Early streamflow records show that 65 to 80 percent of annual flow from small wetland areas can occur during 2 months in spring. Thus, water storage and regulation abilities of wetlands are dependent upon many physical properties of both the wet areas and contributing upland areas—size, topography, source of water, and character of the soil.

Recently, studies completed on northern peat soils show that their water storage characteristics vary considerably. For instance, undecomposed moss peat has many large pores easily drained, while decomposed peats have many small pores not easily drained. In addition, there are striking differences in the rate of water movement within different peat types. Rates as high as 118 feet per day were found in surface horizons of undecomposed moss peat, while movement rates through deeper decomposed peats were as low as 0.016 foot per day.

Thus, in some northern wetlands, surface horizons are most important to watershed management because of high specific yield and faster rates of water movement, both desirable aquifer characteristics. The deeper, more dense horizons provide little storage capacity, and water movement is very slow.

These and other studies in wetland hydrology are already changing some of the early preconceived ideas about the role of forested wetlands in watershed management. They have also pointed out the need for basic research on many phases of water management and wetland hydrology. There is little doubt that forested wetlands will be subject to more intensive use in future years. But whether it will be based upon scientific solutions to hydrologic problems or upon empirical guides and rules-of-thumb for which end results are unknown depends largely on how rapidly new research can provide the needed hydrologic information.