WATER RESOURCES
IMPACT

THE IMPORTANCE OF THE USDA SMALL WATERSHED PROGRAM TO THE RURAL UNITED STATES

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INTRODUCTION

Soil conservation became a national focus during the Dust Bowl days of the 1930s. Drought and poor farming practices followed by years of flooding caused severe erosion across the United States (U.S.). The erosion became a concern of legislative delegates in Washington, DC, and in 1935, the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) (now known as the Natural Resources Conservation Service (NRCS)) was established by Congress. It was during this time that conservationists began developing best management practices for soil conservation, and Congress followed suit with the passage of the following legislation: The Flood Control Act of 1944 (Public Law 78-534) (U.S. Congress, 1944) and The Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) (U.S. Congress, 1954). These statutes created the USDA Small Watershed Program. Through this program, the NRCS provided both financial and technical assistance for the construction of over 11,000 flood control dams and associated conservation practices across the U.S. (Figure 1).

In the late 19th Century, settlement and agriculture in the Great Plains were encouraged by an uncommonly wet period, which seemed to support the theory that "rain follows the plow." This led to the use of poor cultivation methods that eventually contributed to the magnitude of the Dust Bowl.

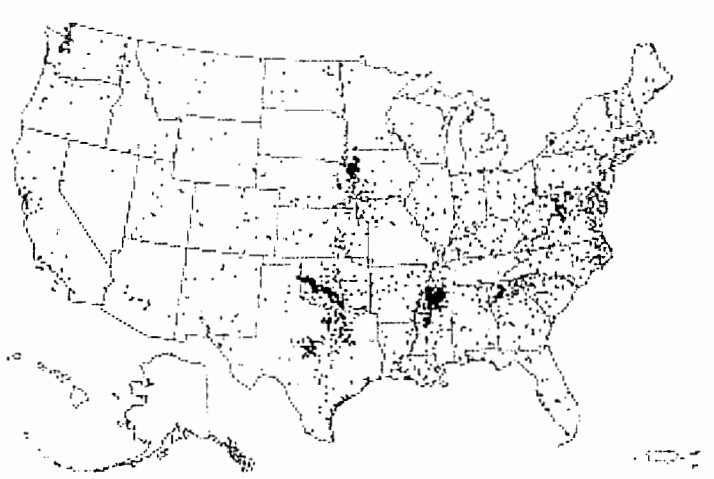

Figure 1. U.S. Map Illustrating the More Than 11,000 Flood Control Dams Constructed Through the USDA Small Watershed Program.

These projects have improved the quality of life and the environment in rural communities by protecting people's lives and property; conserving soil and water resources; reducing flooding; providing economic development, recreation, and water supplies; enhancing water quality; and improving wetlands and wildlife habitat (Figure 2). These projects represent a $15 billion dollar investment and provide $1.5 billion annual benefits (2007 dollars) (Hanson *et al.*, 2007). In 2000, the American Society of Agricultural and Biological Engineers (ASABE) (formerly the American Society of Agricultural Engineers (ASAE)) recognized the USDA Small Watershed Program as one of the Outstanding Achievements of Agricultural Engineering in the 20th Century (Cuello and Huggins, 2000). The infrastructure and technology developed as a result of the program continue to impact rural America as well as similar projects throughout the world.

The Civilian Conservation Corps (CCC), established under President Franklin D. Roosevelt, planted an estimated 300 billion trees. which greatly contributed to the goal of soil erosion control.

The Small Watershed Program is a unique example of a successful partnership between the Federal government, state and local governments, and private landowners. USDA provides technical and financial assistance for the planning, design, and construction of the structural measures in the projects. Project sponsors, generally local conservation districts, special use districts, municipalities, or county government entities are responsible for obtaining land rights needed for installation of the projects and operation and maintenance of the dams for the life of the projects. The private landowners provide the land necessary to construct the dams; many times through voluntary easements. This partnership sets it apart from any other program offered by the government and is responsible for shaping the agricultural landscape as we see it today. The purpose of this article is to highlight the history of this groundbreaking USDA program and more specifically the dams that impact the landscape and the engineering challenges it took to get us where we are today.

ENGINEERING CHALLENGES YESTERDAY AND TODAY

One of the most iconic features of the Small Watershed Program is a watershed dam. These dams were constructed to hold flooding of our agricultural land at bay. These dams are typically earth embankments with an average height of 11 m, but some are known to top 30 m. The dams normally incorporate a principal spillway for the purpose of slowly releasing temporarily stored runoff

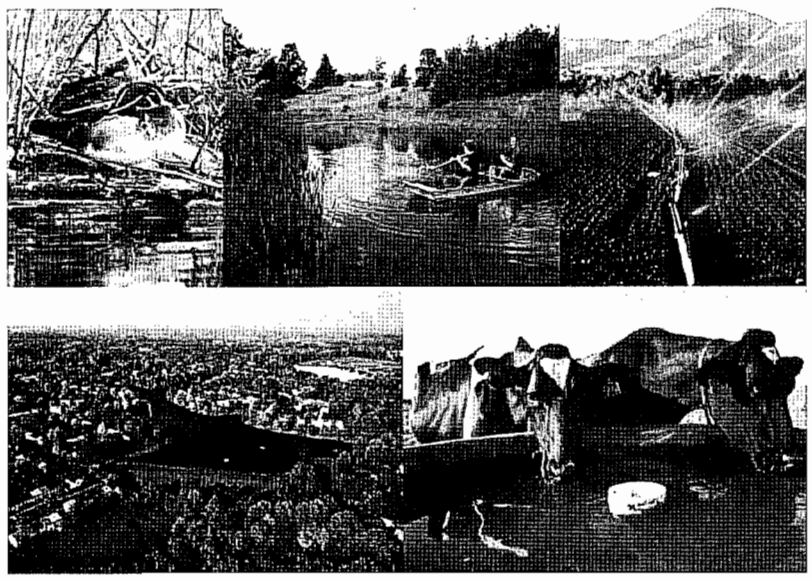

Figure 2. The USDA Small Watershed Program Provides Benefits of Flood Control, Rural and Municipal Water Supply, Wildlife Habitat, Recreation, and Irrigation.

waters and an auxiliary spillway (typically a vegetated channel) for the purpose of conveying extreme flood events safely around the dam to the downstream valley.

These dams are designed according to a hazard classification system. The hazard classification system ranks dams according to downstream risk to life and property. For example, a low hazard dam is typically located in rural or agricultural areas where failure may damage agricultural buildings and land or country roads. A significant hazard dam may result in significant economic damage to a community if the dam should fail, such as loss to a municipal water supply or major transportation routes. A high hazard dam is typically located in more developed areas where failure of the structure may cause loss of life and serious damage to infrastructure (i.e., homes, commercial buildings, public utilities, and major highways and rail systems) (USDA-NRCS, 2005). The design criteria for these dams become more rigorous as the potential for downstream loss of property or life increases.

In the early days of the program, engineers on these projects faced several challenges with regards to the design and construction of these dams. Design criteria involved requirements related to hydrology, geotechnical engineering, hydraulics, and dam safety (Hanson *et al.*, 2007). Engineers were confronted with designing structural components of the dam on limited information and for unfamiliar conditions (i.e., desert to tropical climates, coastal to mountainous landscapes, and/or rural to urban settings). To develop design criteria for this evolving program, design engineers from the USDA-NRCS partnered with USDA-Agricultural Research Service (ARS) engineers and scientists. The ARS engineers and scientists provided research and ultimately design guidance for such things as trash racks for closed-conduit spillways, plunge basins for cantilever pipe outlets, stilling basins, vegetated auxiliary spillways, and roller compacted concrete (RCC) structures. Scientists and engineers also made contributions for determining watershed runoff through hydrologic studies, and they made advancements in the science of embankment design and construction with investigations related to dispersive clays, filter design, and the use of filter diaphragms. The technologies developed by USDA engineers and scientists also shaped the design procedures for other conservation practices like waterways, farm ponds, and grade stabilization structures (Hanson *et al.*, 2007). Ultimately, the innovations developed by the engineers and scientists have led to long standing social and economic benefits (i.e., flood control, wildlife habitat, wetland improvement, municipal and rural water supplies, irrigation supply, and recreation) that will continue for years to come.

With the peak of construction in 1960s (Figure 3), engineers are today faced with new challenges from both social and technical aspects of these dams. Most dams were designed for a 50-year planned service life. Management of the aging infrastructure has become a major undertaking. From a social standpoint, engineers

The creation of Lake Homs Dam in 284 AD was aided by the invention of Roman concrete, which allowed the construction of larger structures. Located in present-day Syria, this 7 meter tall and 2000 meter gravity dam is still in use, and it creates a reservoir with a capacity of 200 million cubic meters.

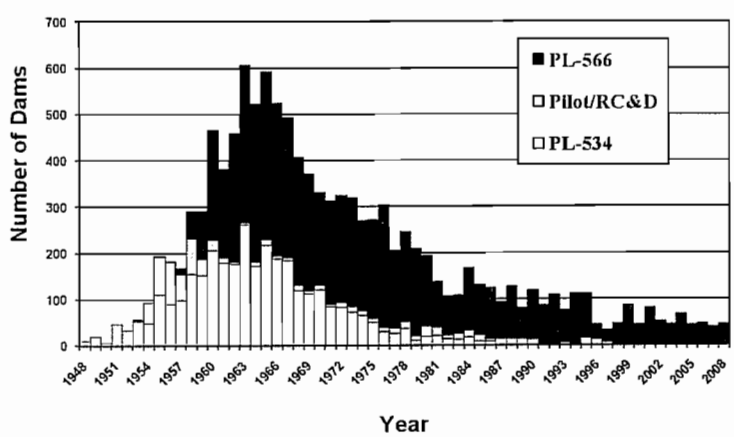

Figure 3. Watershed Projects Constructed by Year.

are confronted with meeting more stringent dam safety laws because changing demographics and hydrology have resulted in hazard classification changes (i.e., low hazard to high hazard) for the structures. Additionally, local interest and understanding of the watershed projects has waned because many of those responsible for maintaining the structures today were not alive when the flooding of the 1940s occurred and therefore the benefits provided by the dams are not always recognized. Accepting the financial and legal burdens of their forefathers is something local sponsors consider when continuing their commitment to the maintenance and operation of these structures. The workforce responsible for developing this integrate infrastructure are quickly approaching retirement age, and transferring the knowledge and experience to a younger generation is a challenge within itself.

From a technical viewpoint, dam safety regulations have evolved resulting in new requirements of risk assessments and the development of emergency action plans. Rehabilitating dams involves new design considerations such as changing the hazard classification from low hazard to high hazard and requiring larger spillways to safely convey larger design floods. NRCS engineers are once again relying on their partnership with ARS engineers and scientists for assistance in developing methods for estimating the likelihood of embankment failure caused by overtopping, internal erosion, foundation seepage, earthquakes, and sliding as well as developing design guidance for the application of roller compacted concrete stepped spillways used for overtopping protection. The continued success of the program is dependent upon the continued success of the local and federal partnership and the on-going benefits these dams continue to provide rural America.

CONCLUSION

The federal and local partnership created by the USDA Small Watershed Program has stood the test of time. Both social and technical challenges were overcome to create an integrated water resources infrastructure that shaped and continues to impact the landscape across our great nation. The benefits of this program are countless. Maintenance of the infrastructure as the dams age and the landscape changes will continue to provide technical, social, and political challenges. To sustain the economic and environmental benefits provided by this program, our generation must rise to the occasion and meet the challenges laid out before us. We owe it to our predecessors as well as to ourselves and for the public health and safety for generations to come.

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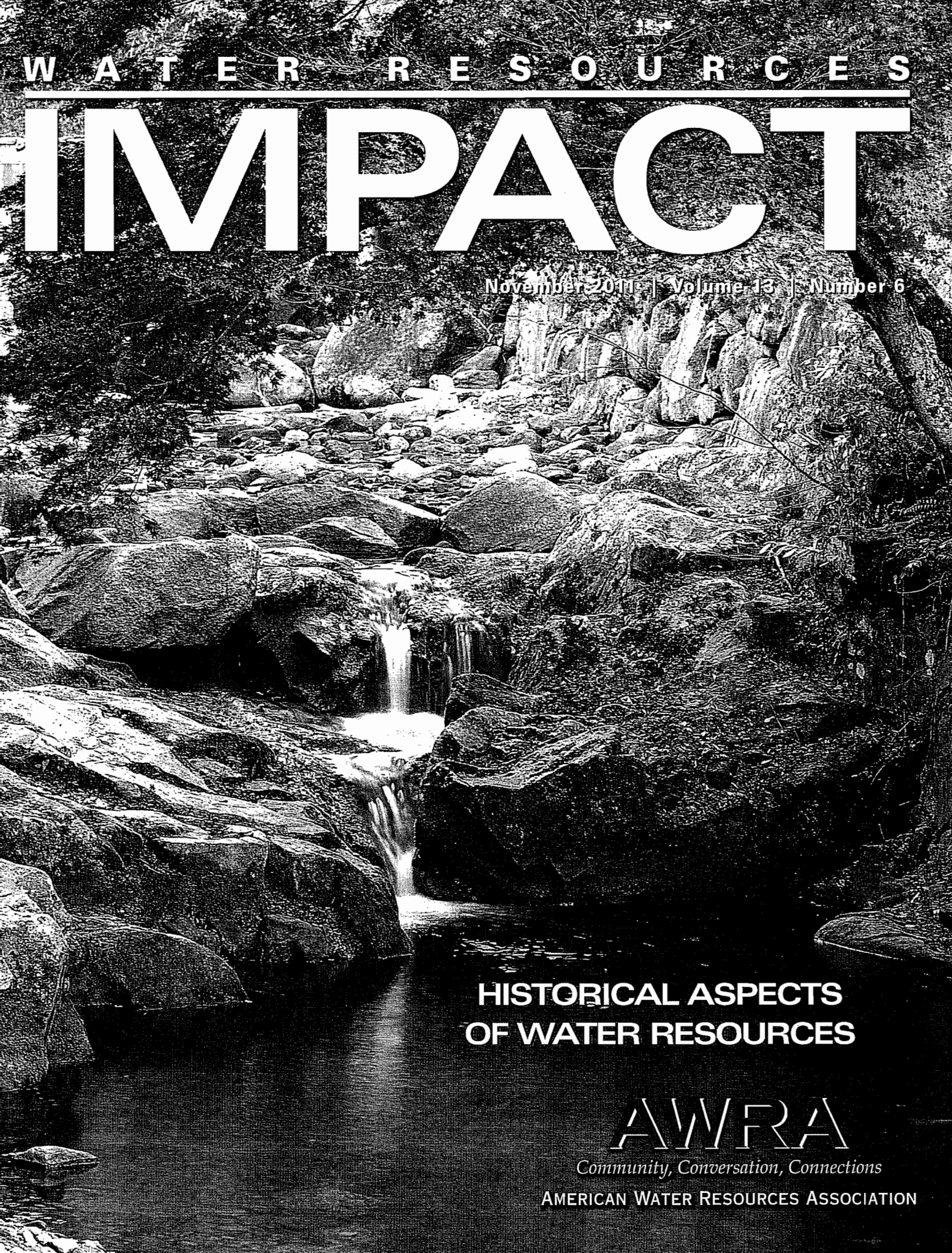

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