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Bioengineering Technique Used for Reservoir Shoreline Erosion Control in Germany

PURPOSE: This technical note documents a low-cost bioengineering technique for reservoir and lake shoreline erosion control used in Germany, and describes how the technique can be applied in the United States.

BACKGROUND: The bioengineering technique used in Germany for erosion control includes a relatively low-cost biodegradable breakwater with wetlands located shoreward. The technique has application for shoreline erosion control on many U.S. reservoirs with dense thickets of young, woody trees, e.g. willow, cottonwood, and alder, located near them since these materials are used in the breakwater. In Germany, the technique has only been applied where water levels do not fluctuate more than 1 m, however, the technique may be acceptable in situations with greater fluctuations.

The technique was adapted from a method used to regain land lost to the North Sea along the North German coastline. The technique was adapted for use in a demonstration study on the Havel Lake in Berlin 8 years ago. Historically, a wetland fringe along most of the lake's perimeter served to reduce wave energies and protect the shoreline from erosion. In recent times, the lake began to lose shoreline due to the impacts of urbanization on the wetlands. The wetlands were being gradually destroyed by a combination of one or more of the following (list is not exhaustive):

- Waves from motorboats (work and sport)
- Choking out by drifting garbage
- Trampling from people and boats which kinks stems
- Depredation by waterfowl (overpopulated due to feeding by people)
- Discharge of toxins and contamination of water by oil, heavy metals, etc.
- Shading of woods close to the shore

Several kilometers of wetlands have been and continue to be restored along the shore, and the shore is now being protected using this technique or a modification of the technique.

The lake forms part of the Havel River, and its water level is controlled within 0.8 to 1.0 m in the vicinity of Berlin. The wind fetches vary from 2 to 5 km.

BIOENGINEERING TECHNIQUE USED: The technique is a combination of a breakwater and planted wetlands shoreward of the breakwater (Figure 1). Wetland plants are often pregrown in a coconut fiber substrate in one of the following forms: fiber pallets (80 by 125 cm); coconut fiber vegetation carpets that are rolled out onsite (0.5 to 2.0 m wide by 5 m long); and 20- by 20- by 20-cm bulbs. All of these forms lend themselves to immediate transfer to the site and short-term shore stabilization until the vegetation becomes established. Wetlands are not usually planted until the breakwater is in place.

The breakwater can be constructed from various materials, e.g., stone or rocks, branches and poles, or fiberschines (large coconut fiber rolls) (Figure 2). This note focuses on one of the more commonly used

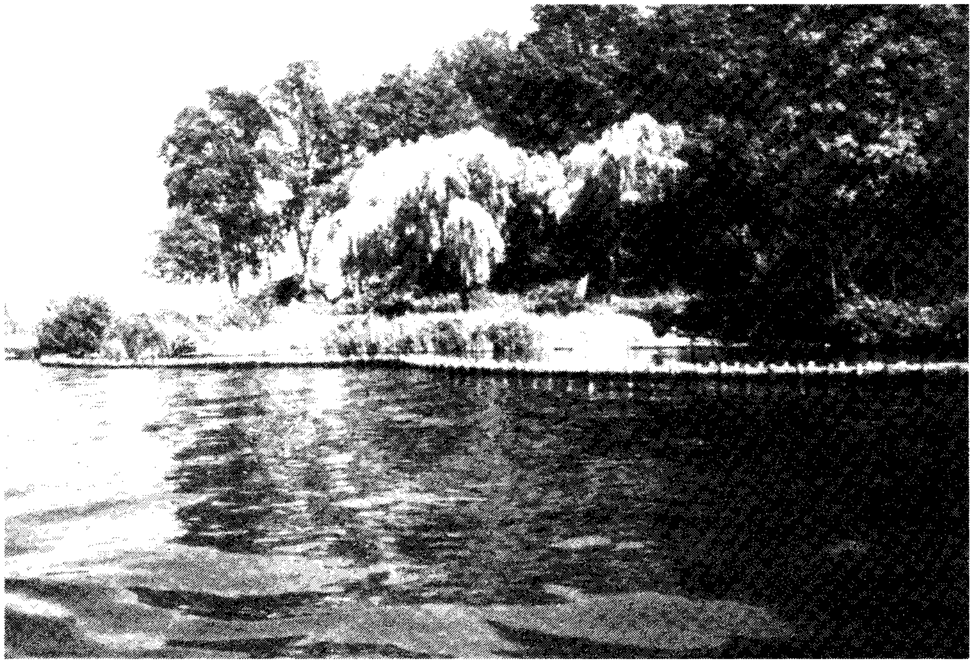

Figure 1. Combination low-cost breakwater with planted wetlands for shoreline erosion control and habitat development

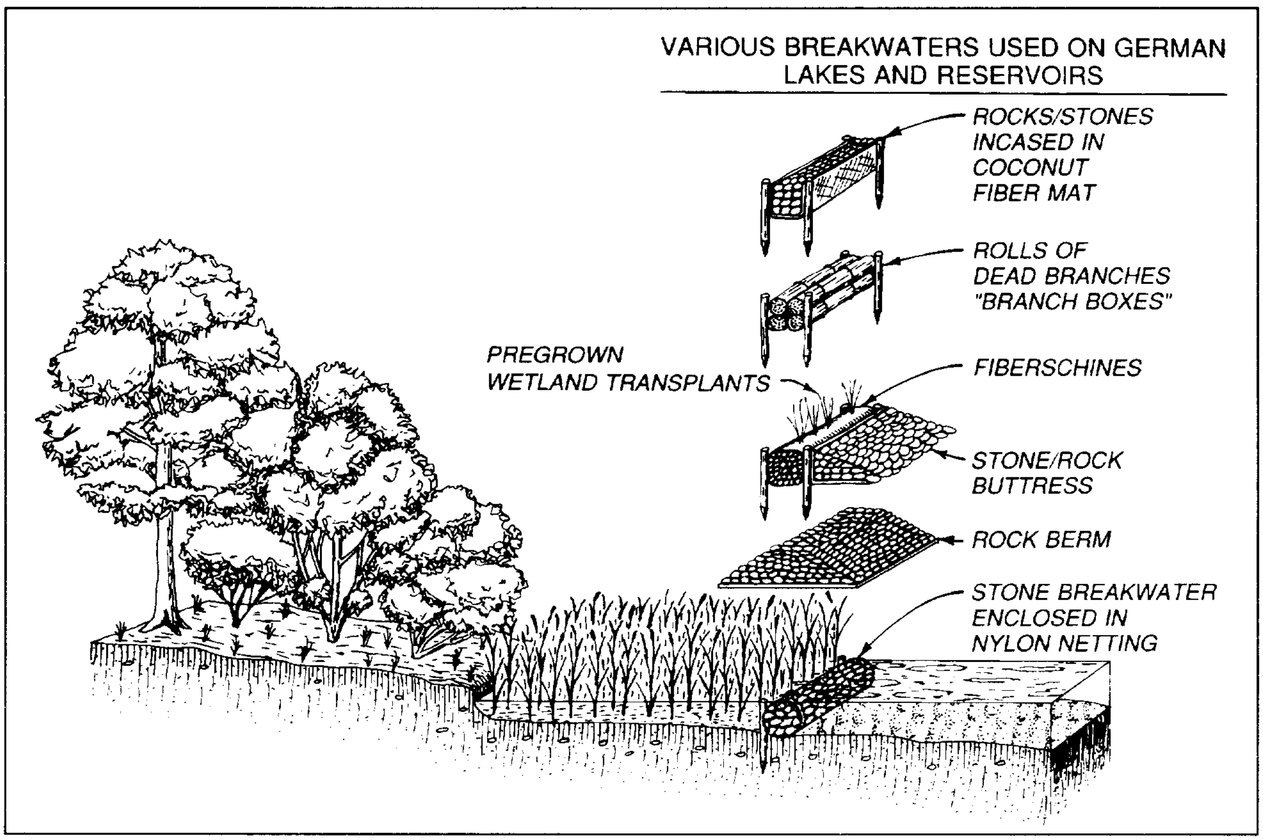

Figure 2. Various combinations of breakwaters and wetlands used on German reservoir and lake shorelines

breakwaters, the branchbox breakwater, which consists of biodegradable materials composed of long poles and faschines (bundles of small dead branches, such as willow and poplar, collected from woodlands (Figure 3)). The breakwater is usually constructed in about 1-m-deep water in the following sequence:

- Place 2- to 3-m-long poles vertically in the lake substrate in two rows about 1 m apart. This is accomplished initially by a hydraulic jet pump; at this point, the poles are not inserted all the way into the substrate, but deep enough to be secure (Figure 4).
- Place a 25-cm-thick layer of dead branches perpendicular to the rows of poles. The branches should be about 1.5 m long. These branches serve as filter material and retard scour at the bottom of the breakwater.
- Wedge faschines between the rows of poles and secure the bundles to the poles by weaving wire rope through screw eyes on each pole like a shoelace; each faschine is about 0.5 m in diameter and varies from 2 to 4 m in length; the screw eyes are placed on the poles a few centimeters above the faschines.
- Drive the poles down firmly with a pneumatic hammer mounted on a barge or some other mechanical device. This tightens the entire breakwater system.
- Cut off the tops of the poles to about 30 to 60 cm above the tops of the faschines, thereby completing the breakwater (Figure 5).

After breakwater construction, wetland plants pregrown in fiberschines, pallets, and bulbs are transferred intact to the site and installed. The fiberschines and pallets are secured to the substrate by driving long stakes into them and tying a rope between the stakes. The construction is then tightened by further driving the stakes into the substrate so that all is secure.

Wetland plants most often used in the lake around Berlin included the following:

- *Acorus calamus* — Sweetflag
- *Carex gracilis* — Sedge

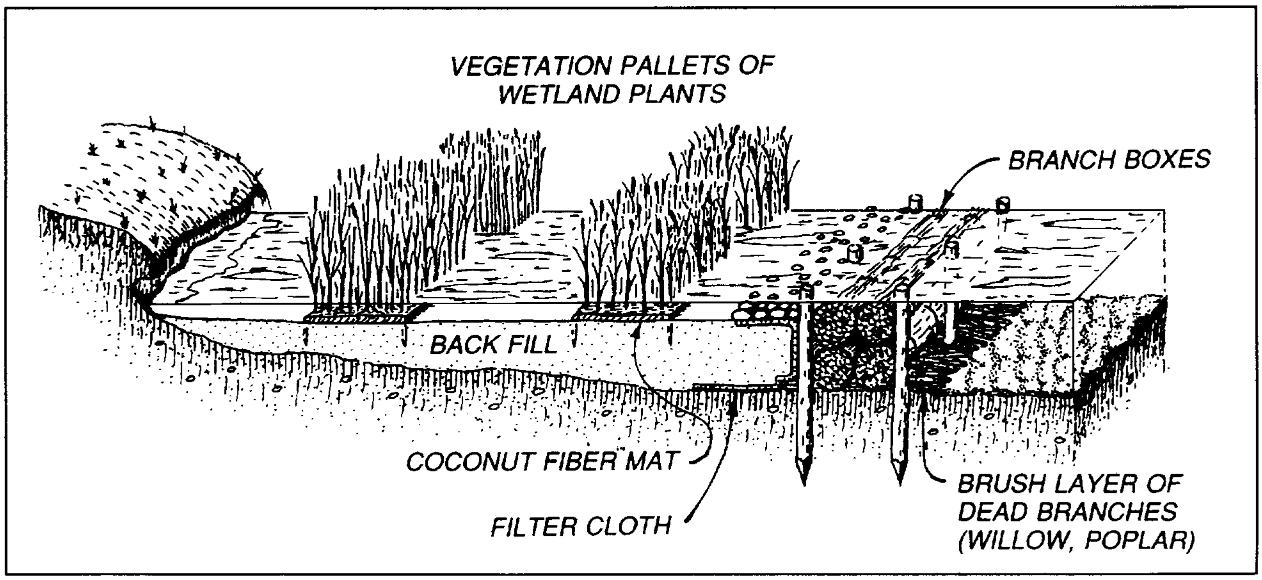

Figure 3. Branchbox breakwater with wetlands shoreward

Figure 4. Poles that are initially placed with a jetpump

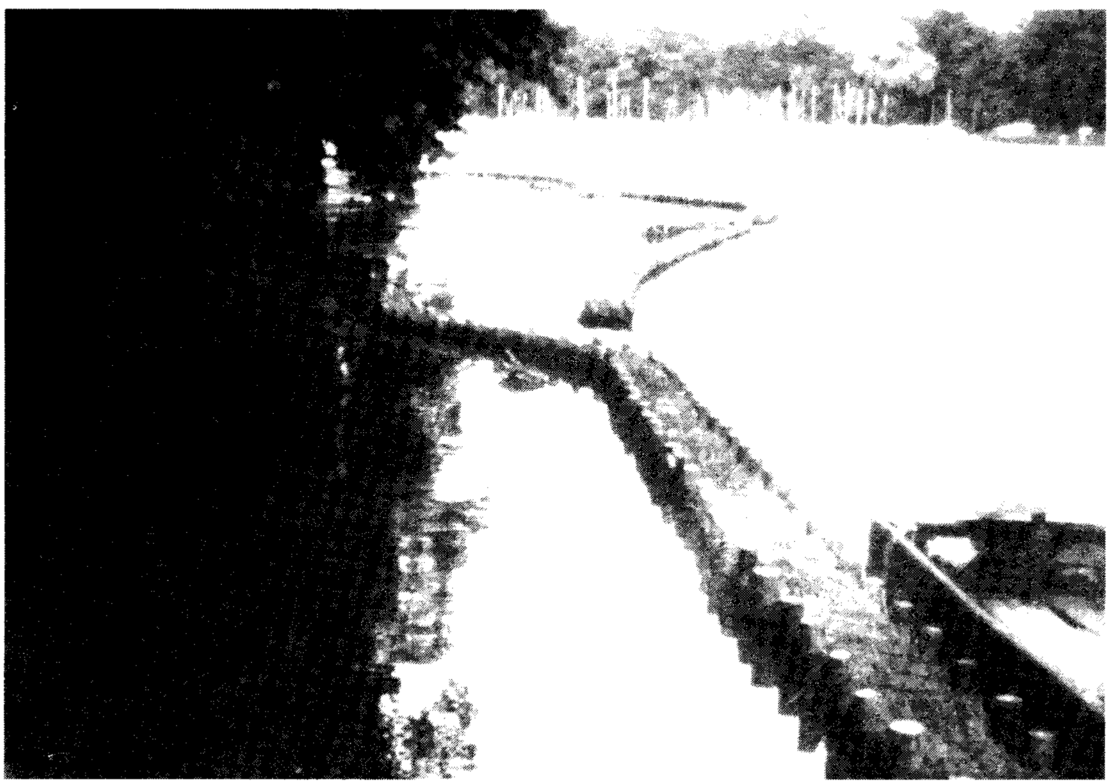

Figure 5. Completed branchbox breakwater

- *Iris pseudacorus* — Yellow flag
- *Phragmites australis* — Common reed
- *Schoenoplectus lacustris* — Bulrush
- *Typha anhustifolia* — Narrowleaved cattail
- *Typha latifolia* — Broadleaved cattail

These wetland plants and others are usually placed in zones of water levels varying between approximately 0.5 m below average water level and about 0.3 m above the average water level.

COSTS: For this wetland system (1991 prices) including the branchbox breakwater, wetland plants installed as pallets and bulbs, and coconut-fiber filter fabric were between $400 and $460 per linear meter for a 10- to 20-m swath from the breakwater landward. Generally, costs for bioengineering alternatives are a fraction of the costs of traditional alternatives such as riprap armorment. It should be noted that construction costs could be lower in Germany because of the existing equipment such as barge-mounted pneumatic hammers and shallow-draft barges and boats. Similar equipment could be made in the United States, however.

CONCLUSION: The branchbox breakwater with associated wetlands is a feasible technique for cost effectively controlling shoreline erosion in reservoirs with little water-level fluctuation. It has the added benefit of providing wetland habitat in harmony with nature. The breakwater is also biodegradable, which improves its acceptability to environmental agencies and groups. This system can be used on reservoir shorelines receiving fluctuation in excess of 1 m, but caution should be exercised and a low-cost demonstration is advised before pursuing large-scale shoreline erosion control efforts on reservoirs of this type.

ADVANTAGES: This technique permits effective, low-cost erosion control without destroying shoreline habitat; in fact, wetlands which enhance the reservoir's shoreline habitat are created. In addition, the wetlands provide sediment entrapment, water quality improvement, aesthetic quality improvement, protection of cultural and archeological resources, and other beneficial functions.

AVAILABILITY: Various modifications of the technique have been used on reservoirs and lakes near Berlin, Pritzwalk, and many other locations throughout Germany. The technique described below was developed and tested by: Lothar Bestmann, Bestmann Ingenieurbiologie (Bioengineering) GmbH, Pinneberger Str. 203, D-2000 Wedel/Holst., Germany, Phone: 011-49-4103-84036, Fax: 011-49-4103-4104

Information is also available on this technique from the following source: Bestmann Green Systems, Attn: Ms. Wendi Goldsmith, P.O. Box 88, Boston, MA 02133, Phone: (617) 723-9404, Fax: (617) 723-9430

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