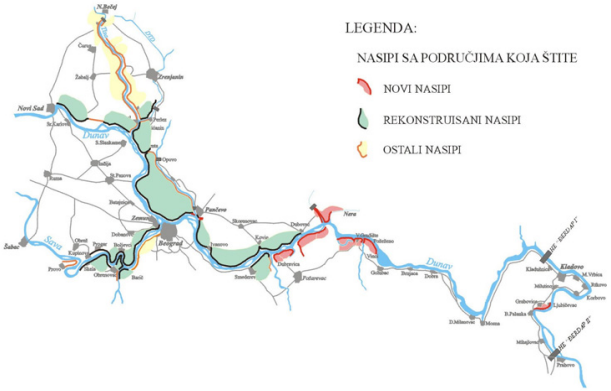
Flood Protection Of The Danube's Riparian Lands Adversely Affected By Iron Gate 1 (Djerdap 1) And Iron Gate 2 (Djerdap 2) HPP Reservoirs



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Electric Power Industry of Serbia/Iron Gate Hydroelectric Power Plants
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From the beginning of construction and through the subsequent operation of the Iron Gate 1 (Djerdap 1) and Iron Gate 2 (Djerdap 2) Hydroelectric Power Plants (HPPs), extensive flood control projects have been undertaken as part of comprehensive measures aimed at protecting riparian lands virtually along the entire length of the Danube's back-up flow of over 200 km.

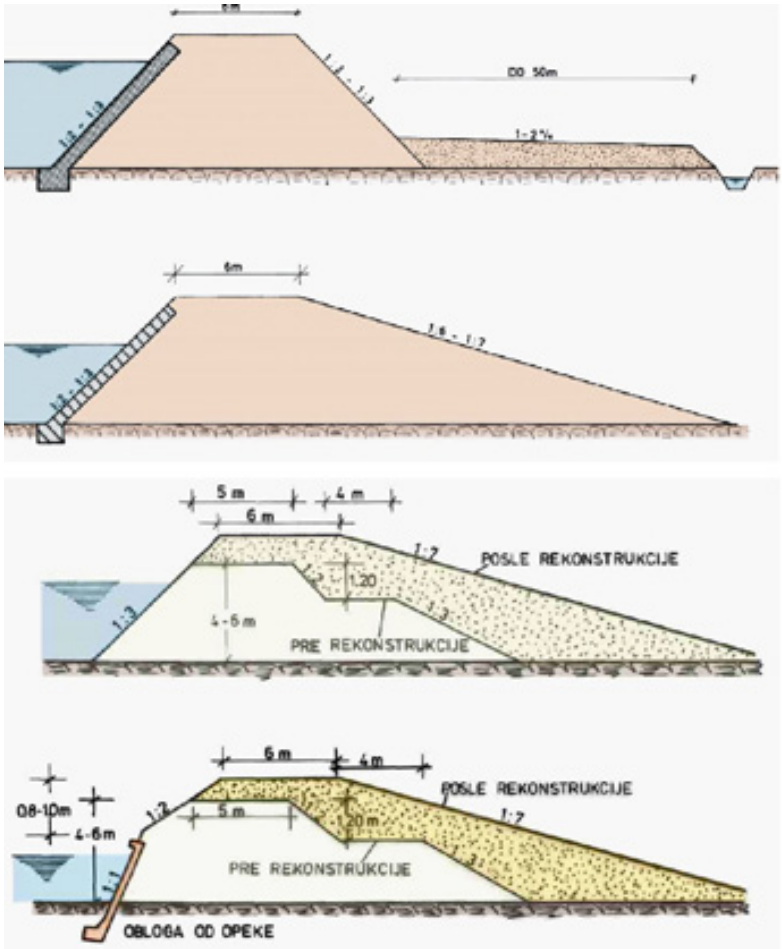
Prior to impoundment, flood protection measures included levees along endangered sections of this stretch of the Danube and its tributaries (generally structures of modest size that did not provide reliable protection and necessitated sizeable efforts during and after a flood event). Several low-lying areas were left unprotected and were vulnerable to floods nearly every year and often several times a year.

New levees have since been erected and existing levees of inadequate dimensions reconstructed to upgrade the protection of urban and rural areas within the zone of influence of the Iron Gate reservoirs.

To assess flood protection effectiveness and design additional protection measures, an annual monitoring program was established to track the impact of the reservoirs on the levees and the riparian lands. The program is comprised of:

- Regular monitoring of levee status;
- Recording and assessment of any safety-related problems;
- Establishment and review of flood protection criteria;
- Implementation of emergency response measures and rehabilitation activities, as needed; and
- Undertaking of reconstruction and upgrading projects, as needed.

The monitoring data compiled over the years show that the newly-constructed and reconstructed levees have provided effective flood protection and that the performance of the overall flood protection system was not threatened during periods of extremely high flows (in 2005, 2006 and 2010).



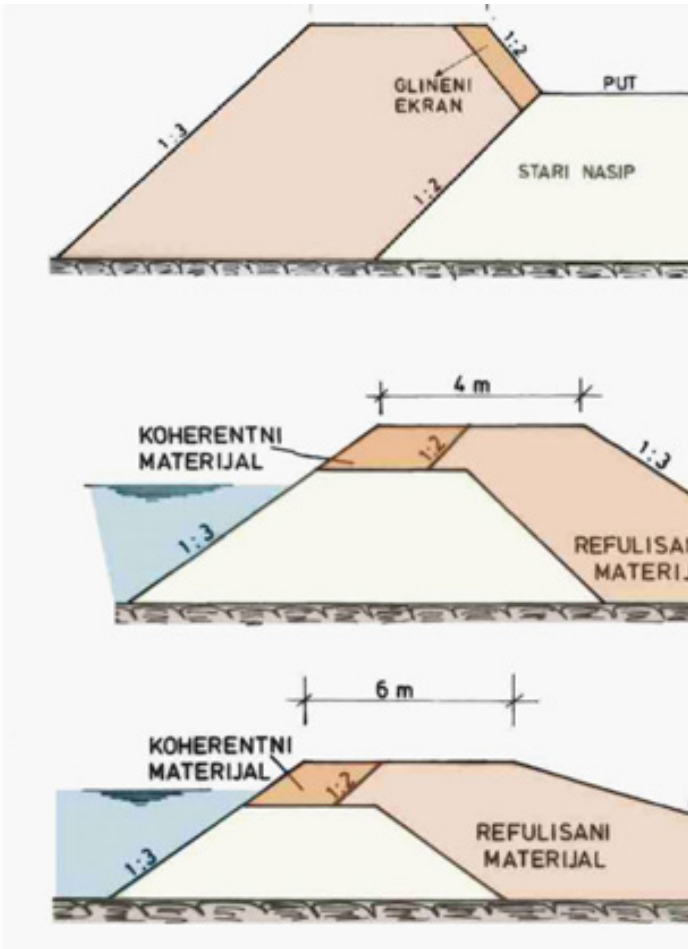


Figure 2: Main types of new and reconstructed levees, and reconstruction methods

Long-term monitoring data and observed functional problems indicate that the levees are part of a larger flood protection system, which encompasses:

- Riverbanks prone to caving;
- Floodplains and riverside forests (which have to be preserved under impounding conditions, including drainage of depressions);
- Levee embankments and outer linings which provide wave protection (occasionally exhibiting deformation and caving and insufficient embankment height);
- Protected areas, including canals, meanders, forests, structures, etc.

Flood waves threaten levee stability and reduce urban and rural flood safety. Adverse events can be classified into those that impact protected areas and those that impact unprotected areas.
Problems noted in the field were addressed by emergency response measures and rehabilitation activities, as well as by reconstruction projects needed to control high water levels resulting from changes in the hydroelectric power plant operating regime.

Other problems were generally caused by incomplete maintenance or reconstruction programs. To date, the following problems have been identified in protected areas along levees:

- Inability to access and monitor the immediate zone of the levee toe;
- High piezometric head in protected areas, along remnants of abandoned river channels and excavated canals, and in depressions;
- Structures built along levees (e.g., dug wells and septic tanks) and deforestation, which preclude unconditional levee safety.