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Impacts of siltation in dams and reserviors

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Abstract

Silt is somewhere between the size of sand and clay, and is an important component in the sedimentary dynamics of rivers. Silt comes in several forms. It might be found in the soil underwater or as sediment suspended in river water. Silt is geologically classified by its grain size and texture going through a sieve. Letters are assigned to the grain of soil, whether it is gravel, sand, silt, clay, or organic. Then, it is further delineated as to whether the sample is poorly graded, well-graded, has a high plasticity, or low plasticity. The sample composition is determined by passing it through differently sized sieves, and the result is classified with the combination of letters assigned to it based on its physiochemical characteristics.

Siltation is a process of accumulation of sediments (dust, soil, sand, gravels and other particles) in the river and dam it is called as siltation. These particles come from catchment area (area on which rain occurs and come to river) river banks (sides of river) and river bed with the running water and disposition in the dam and river .It refers both to the increased concentration of suspended sediments, and to the increased accumulation (temporary or permanent) of fine sediments on bottoms where they are undesirable. Siltation is most often caused by soil erosion or sediment spill.

Siltation in the reservoir is due to stagnant water in huge water storage. All rivers naturally carry Silt in their flow due to velocity of flow. Silt is deposited all along river banks in normal floods. Formation of big reservoirs disturbs silting pattern all along the banks. Silting in the reservoir reduces the live storage. Hence Reservoir capacity is designed to accommodate the expected quantity of Silt in life time of dam.

Introduction

Silt is a granular material derived from soil or rock of a grain size between sand and clay. It may occur as a soil or as suspended sediment in a surface "water body" (Water Framework Directive speak for river, stream, lake or groundwater source). It may also exist as soil deposited on a river or lake bed. Siltation is very bad news for our rivers and many of their inhabitants. With faster run-offs from forestry, increased grazing pressures and, typically, potato, strawberry or maize crops, fine sediment loads on some streams smother the bed and kill off invertebrates and fish eggs, resulting in reduced spawning success or abandonment by fish. The fine sediment loading of our rivers has trebled since 1980 and in the most severely affected streams egg survival has been reduced to 0%. Much of this damage is avoidable and our knowledge is increasing of the whereabouts of vulnerable sites and which land use practices put the rivers at the greatest risk

Rapidly flowing rivers from the high lands bring fine soil particles called silt through the process of erosion, The silt gets laterally deposited on the banks of the rivers. When the river is dammed, its flow velocity suddenly gets lessened and stagnant or semi-stagnant conditions result. The buoyancy of the silt particles then gets lowered and they slowly or gradually settle on the reservoir bed or bottom thereby filling the same. In the course of time, the live storage of the reservoir gets reduced. This phenomenon is called siltation

Rate of sedimentation

The rate of reservoir sedimentation depends mainly on the size of a reservoir relative to the amount of sediment flowing into it: a small reservoir on an extremely muddy river will rapidly lose capacity; a large reservoir on a very clear river may take centuries to lose an appreciable amount of storage. Large reservoirs in the US lose storage capacity at an average rate of around 0.2 per cent per year, with regional variations ranging from 0.5 per cent per year in the Pacific states to just 0.1 per cent in reservoirs in the northeast. Major reservoirs in China lose capacity at an annual rate of 2.3 per cent.

Apart from rapidly filling their reservoirs, sediment–filled rivers also cause headaches for dam operators due to the abrasion of turbines and other dam components. The efficiency of a turbine is largely dependent upon the hydraulic properties of its blades, just as an aeroplane depends on the aerodynamic properties of its wings. The erosion and cracking of the tips of turbine blades by water–borne sand and silt considerably reduces their generating efficiency and can require expensive repairs

Main impacts of reservoirs sedimentation

.Storage loss

It is usualy the main impact for dams devoted to water storage as their benefit is quite proportional to the storage. This impact is lower for dams devoted to hydropower: their benefit may possibly be reduced by under 20% when the reservoir is 80% filled (including a large part in the designed dead storage).

Turbines abrasion:

Sediment coarser than 0,1 mm may greatly accelerate the erosion of turbines parts; even smaller grain sizes may cause damages if containing quartz. It may be the main siltation problem for high head hydropower. Also sediment concentration and total head are important factors.

Downstream impacts

River reaches downstream of dams suffer large environmental impacts due to flow changes, reduction of sediment load, altered nutrient dynamics, temperature changes, and the presence of the migration barrier imposed by the structure and the upstream impoundment.

Clear water released from the reservoir will cause down stream erosion and possibly bank failures.Sediment trapping by dams can even affect coastal morphology. One way of reducing this impact may be to build run-of-river hydroelectric projects which would allow passage of 100% of the fines and an important portion of the bed load.

Concepts Of Reservoir Life

With reasonable levels of maintenance, the structural life of dams is virtually unlimited, and most reservoirs are designed and operated on the concept of a finite life which will ultimately be terminated by sediment accumulation rather than structural obsolescence.

Design life is the planning period used for designing the reservoir project. Planning and economic studies are typically based on a period not exceeding 50 years, whereas engineering studies often incorporate a 100-year sediment storage pool in the design.

The target of a very long reservoir life should be a key point of a right design and management of siltation problems.

Factors controlling siltation

Silt barrier

When choosing a barrier to control the silt and turbidity in your location, there are several different factors you are typically advised to consider in order to select the most appropriate barrier. Factors typically include the following:

- **Water Conditions:** Since your barrier will be operating in a water area, it is especially important that various aspects of your water location be properly considered. Water conditions include:
    - Water Velocity (typical flow speed)
    - Waves (height, frequency, etc.)
    - Tides

- **Wind:** This can also play a factor in your site conditions. In general, it is advised that a typical wind speed and/or direction is noted if wind is frequently present on your site.

- **Site Conditions:** It is also important to take into consideration various site conditions including:
    - Soil/Silt/Turbidity Type (is it contaminated?)
    - Project Duration
    - Site-Specific Conditions and Requirements

Silt Barriers typically come in sections that measure either **50 or 100 feet in length.** Depths can vary anywhere from **3 to 100 feet** and are dependant on your specific water location

Removing stored sediment:

Sediment deposits may be mechanically removed from reservoirs by dry excavation or hydraulic dredging and hydro-suction.

The annual worldwide stored sediment is close to 40 Billion m^3; possibly half is in the designed dead storage.

Dry Excavation

All methods of mechanical excavation are costly because of the large volumes of material involved and, frequently, the difficulty of obtaining suitable sites for placement of the excavated material within an economic distance of the impoundment. However, once sediments are deposited in a reservoir, excavation may be the best management option available.

Hydraulic dredging

The solutions may be very different for small irrigation dams and for large hydropower reservoirs. They have been presented in ICOLD Bulletin 144 (chapter 3.4.8.)

– For rather small irrigation reservoirs siphon dredges may be used and do not need pumps. The slurry is forced through the pipeline by the differential head between the water surface in the reservoir and the discharge point located at the lowest possible place downstream of the dam. It seems adapted to some dozen thousands m^3 of silt per year.

– Dredged sediments may be sent downstream to the river. They may also be sent to a disposal area and the water flown back to the reservoir (Mechra reservoir in Morocco: ICOLD Q.89).

Phased dam construction:

It may be difficult to avoid the reservoir siltation but many earth fill irrigation dams may be designed for an easy level increase after 20 or 100 years of operation. Raising by 5 m a 30 m high dam may quite double the storage when necessary.