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ON THE SLUMPINGS OF THE VALLEYS ENCOMPASSING IDUKKI RESERVOIR, CENTRAL KERALA, INDIA.

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ABSTRACT

The nature of valley slumping and its effect on the reservoir capacity, have been assessed by studying 200 valley slumpings encompassing the Idukki reservoir, using aerial photographs, field checks and actual field measurements. The study indicates that the siltation from the valley slumps is not so alarming as to affect the storage capacity of the reservoir. It has, however, affected the degradation of slopes causing erosion of precious soil, which, if not checked, would result in ultimate destruction of the rich forest of the catchment area. Different methods to prevent valley slumping have been suggested.

INTRODUCTION

In the following account, the effect of valley slumping in one of the biggest reservoirs in western Ghats, namely, the reservoir of Idukki Hydro-electric project has been studied. Slumping of valleys encompassing a reservoir[1] would result in (i) degradation of slopes involving erosion of soil; (ii) siltation of reservoir due to accumulation of sediments derived from slides resulting in loss of storage capacity, and (iii) progressive degradation and ultimate destruction of forest cover along the slope. In this background, an attempt has been made to understand the reasons of valley slumping, to assess the quantum of silt already dislodged from the failed horizons and to suggest appropriate stabilization techniques to provide for healthy slope control for the valley slopes.

Study Area

The Idukki reservoir, in the Idukki district of Kerala State, is located between lat. 9°45′ and 9°51′N and long. 76°53′ and 77°05′E. (figure 1) and is surrounded by tropical forest of the Western Ghats.

The reservoir is formed by three dams; Idukki (170.73 m high), Cheruthoni (135.67 m high) and Kulamavu (99.97 m high)[2]. The reservoir has a total storage capacity[3] of 1691 m.cu.m. and a usable storage capacity of 1008 m.cu.m. It occupies an area of 53 sq. km. The average rainfall[3] in the watershed region varies from 444.5 cm to 508 cm.

Geologically, the catchment area comprises of charnockites and hornblende biotite gneiss and intrusive granites.[4,5]. In general, these rocks have been subjected to varying degrees of weathering, upto 6 m. The relief is diverse, ranging from gentle ridges to precipitous hills. The drainage pattern is mainly sub-parallel, being controlled by large scale structures and lineaments[6].

METHODOLOGY

Slumpings were first plotted by studying aerial photographs of the reservoir area on a scale 1:15,000. On photographs, these failed regions show up as lighter grey with a dark grey tone at its near vertical headwall. Regions of steeper ground slopes (> 25°) with thick soil-cover and no vegetation, have been demarcated as potential regions of failure. The slumpings have been studied further by field checking and detailed measurements in order to get particulars of the volume of silt brought down by each slide. The silt from the slumped horizon has been estimated assuming that a rectangular mass of overburden has been removed from above the full reservoir level and deposited in the reservoir. Figure 2 is a simple model of

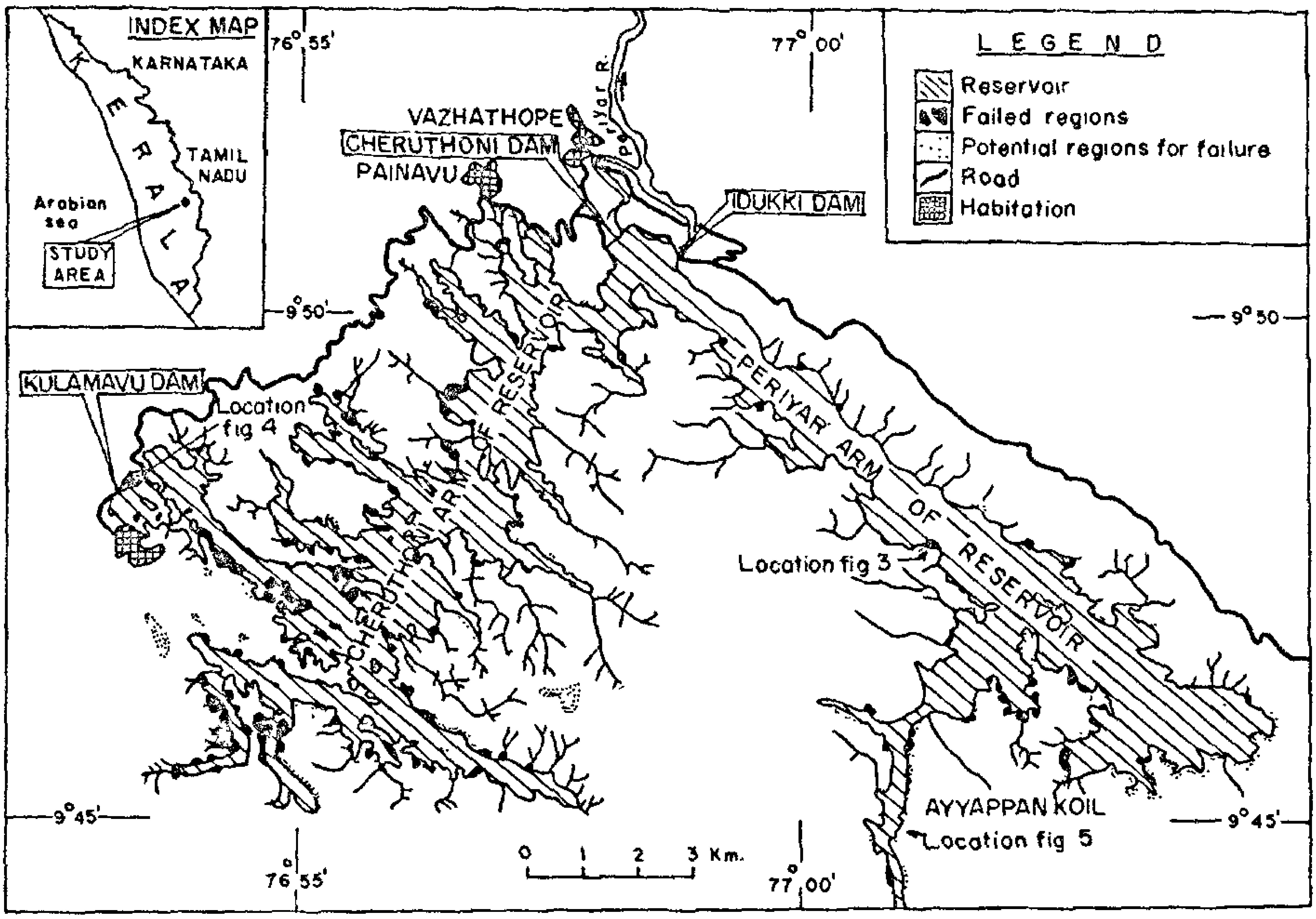

Figure 1. Map showing locations of slumping along valleys bounding Idukki reservoir.

a slump from which a rectangular mass of overburden has slid down to the reservoir.

DISCUSSION

The notable feature found in these valleys is the slumpings of the weathered mantle. They are normal gravity slides of overburden which moves down on a curved or spoonlike surface, occurring either within the overburden or at the junction of the basal rock and the overburden (figures 3 and 4). These slumpings are also known as "circular failures"[7].

The mechanism of these failures could be explained as follows: The reservoir obstructs groundwater flow upsetting the groundwater regime and locally raises the water table. The soil not saturated before the infilling of the reservoir gets saturated and weaker, and becomes unstable. Instability would manifest itself by the development of slip surfaces and movements initiated along the same. Added to that, the low shearing strength of soil hastens the mechanism of failure.

The present study has revealed that slumped horizons and regions of potential slumping are more towards the upstream of the reservoir (figure 1). In addition to the causes of failures mentioned above, larger number of perennial rivulets in the upstream side probably caused more slumpings in the upstream side. The area affected by water fluctuation would also be more in the upstream.

In general, when the reservoir level goes down, valleys with steeper slopes and high moisture content get exposed making easy for the cohesive soil to fail. Lack of vegetation either localises the failure or augments the mechanism. Further, in the valley slopes of unconsolidated soil and clay, as in the present case, there is a steady decrease in the strength of soil towards a long term residual condition. Repeated stages of swelling and softening as a result of reservoir fluctuation cause dissipation of residual stress. Ingress of water along fissures (figure 5), in such conditions, initiates slumping. Presence of fissures, non-uniformity of shear stress along potential failures and local anthrapogenic overstressing would lead to progressive slope failures.

Volume of silt contributed to the reservoir by each

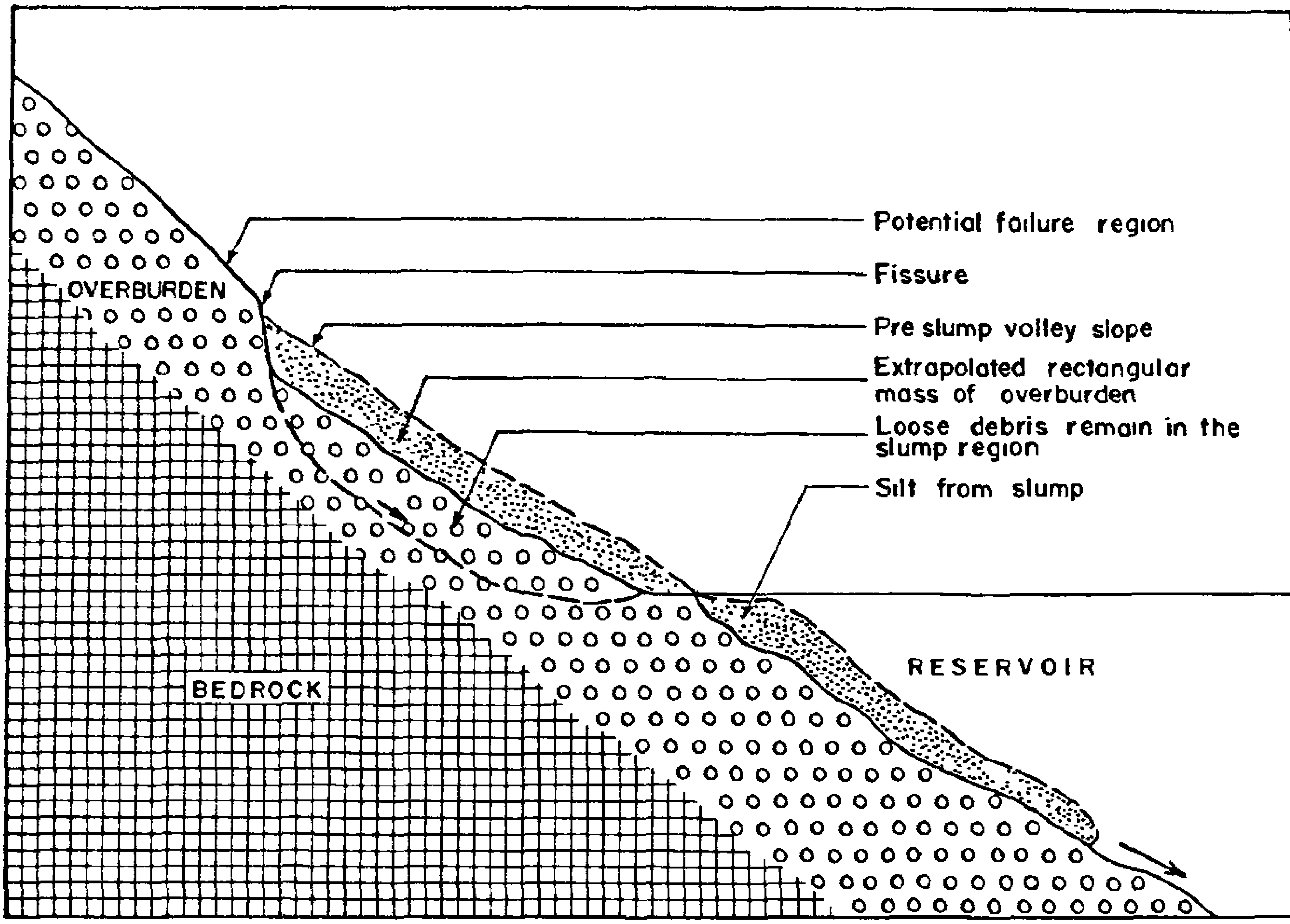

Figure 2. A schematic representation on the mechanism of slumping.

Figure 3. A major slumping in Periyar arm of the Idukki reservoir. The terracing on the slope is the result of beach action of reservoir water at different periods of lowering.

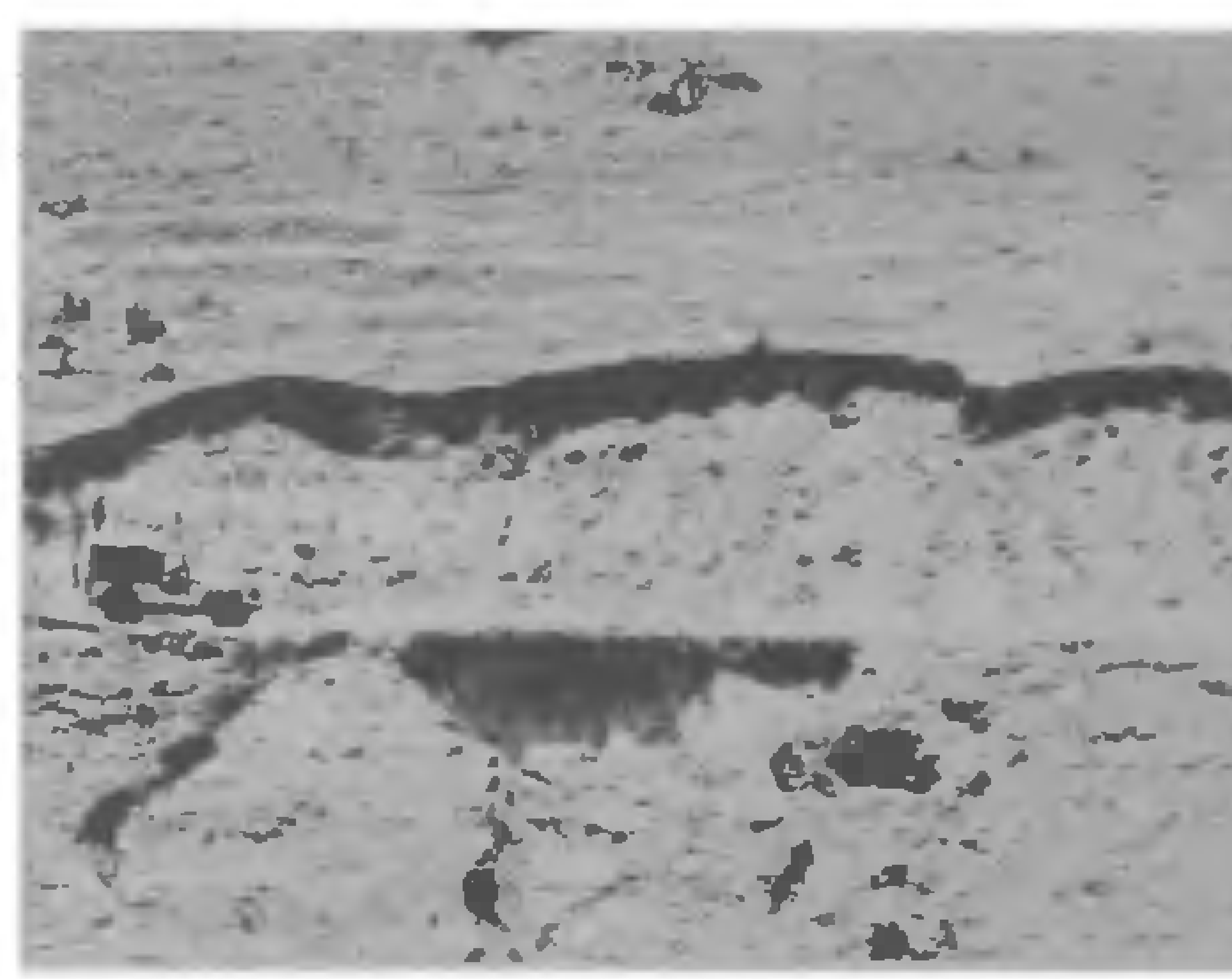

Figure 4. Another major slumping in the Cheruthoni arm of Idukki reservoir.

slumping has varied between 6 m^3 to 17820 m^3 and the total contribution to the reservoir from all the slumpings is calculated to be the order of 3×10^5 m^3. This siltation does not appear to be significant considering the total storage capacity of the reservoir (1691×10^6 m^3 at FRL). However, unless proper

Figure 5. Formation of a fissure prior to slumping near Ayyappancoil. The fissure initiates the slumping.

steps are taken up immediately to stabilise the valleys, this may create serious problems of siltation from the valleys of Idukki reservoir in future, since the management and protection of the existing forest are extremely poor. Besides, indiscriminate felling of trees has aggravated the situation. If unchecked, the whole precious top soil which supports the forest will be lost, resulting in denudation and removal of the forest forever.

Methods of slope control and stabilisation

Slide prevention may be brought about by reducing the activating forces, by increasing the forces resisting the movement or by avoiding or eliminating the slide itself. Reduction of activating forces can be accomplished by removing material from that part of the slide which provides the force and in the case of soils by drainage which reduces the pore pressures and the bulk density. Excavation. involving removal of material from the head of an unstable slope, flattening of slope, benching of slope or complete removal of unstable material affords stabilisation by increasing the shearing resistance remaining[8]. Afforestation and proper management of existing forest help to stabilize the valley. *This appears to us the most economical and effective measure of stabilisation and the most satisfactory trees would be those having high transpiration rates and water intake capacity.* For this purpose, it appears that the deciduous trees are the most suitable ones.

ACKNOWLEDGEMENT

The investigation is part of a project sponsored by the Department of Environment, Government of India and the authors are indebted to the Department for financial support. The authors are grateful to Dr A. K. Ganguly for his keen interest and advice, to Dr Harsh K. Gupta, for facilities and encouragement.

15 July 1983; Revised 12 September 1983

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