

5

CRANFIELD UNIVERSITY

School of Agriculture, Food and Environment

SILSOE COLLEGE

NATURAL RESOURCES MANAGEMENT DEPARTMENT

Roshan Priyantha de Silva

**Estimating Groundwater Recharge with Limited Resources, with Special
Emphasis on Spatial Variability: A Study in the Dry Zone of Sri Lanka**

REFERENCE ONLY

Supervisor : Dr. R. C. Carter

This thesis is submitted in fulfilment of the requirements for the degree of Doctor
of Philosophy.

NOVEMBER 1996

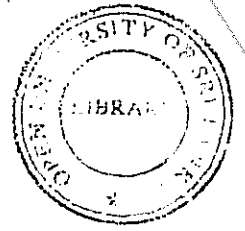
62305



Abstract
Silsoe College

Roshan Priyantha de Silva

PhD - 1996



Estimating Groundwater Recharge with Limited Resources, with Special
Emphasis on Spatial Variability: A Study in the Dry Zone of Sri Lanka

This thesis addresses the important question of estimating groundwater recharge considering its spatial varying nature, with special reference to the dry zone of Sri Lanka. Recharge which is considered in this thesis as the rate of water reaching the water table, is central to many key issues related to the development of groundwater resources, which has become necessary in the social and economic development of increasing populations in many parts of the world and that of Sri Lanka.

The methods of estimating recharge are critically reviewed and soil-water budgeting method and the chloride profiling method are initially identified to be promising methods considering the resources available, climate and hydrogeology of the dry zone and the necessity to estimate recharge at a number of different sampling points.

However, a more thorough investigation of the two methods including the application of the methods to 62 different points at 7 different locations in the dry zone of Sri Lanka shows that the chloride method is the preferred method to estimate recharge. The problems of soil water budgeting models are associated with the non availability of necessary information to model the processes of interception, runoff, preferential flow and actual evapotranspiration. All of these processes need to be modelled accurately and calibrated to determine relevant model parameters if soil water budget models are to be used in estimating recharge in the dry zone. Otherwise as shown in this study, the estimates of recharge at a point with soil water budgets is of limited use, because of the rather wide range of estimates.

The assumptions made in the theory of the chloride method appear to be valid in the dry zone and the diffusive and dispersive fluxes were found to be negligible in all the sites and therefore, the convective flow dominates the movement of pore water in the dry zone. Hence, knowing the rainfall, chloride concentrations in rain and in soil water, it is possible to estimate recharge in the dry zone with the chloride profiling method.

In the dry zone, it is likely that the actual recharge is significantly different from the potential recharge suggesting significant amounts of horizontal flow of water in the shallow unsaturated zone to streams and rivers. These actual recharge rates estimated with the chloride method are low (< 66 mm/year) for the dry zone and therefore, the groundwater resource has to be carefully managed.

Recharge is also found to be spatially varying at all sites. This variability appear to be true variability rather than an artefact of the method used to assess the variability. The available evidence suggests that the spatial variability of recharge at a site is caused by the vegetation and soil properties of the shallow unsaturated zone (probably the root zone). The degree of spatial variability of recharge was found to differ at different locations and appears to be less in more dry areas and in areas of clayey top soil, both in the dry zone and the other parts of the world. The spatial variability of recharge is also found to be approximately log normally distributed in small areas (1 ha) in the dry zone.

A simple methodology is proposed to estimate rainfed recharge in the dry zone which takes account of the spatial variability.

Keywords : Groundwater Recharge, Spatial Variability, Soil Water Budget, Unsaturated Zone Chloride Profiling Method, Dry Zone, Sri Lanka