A SURVEY OF RESEARCH PROBLEMS IN HYDRAULIC ENGINEERING IN TRINIDAD AND TOBAGO

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Summary

An overview of research problems in Hydraulic Engineering in Trinidad and Tobago is presented by means of a survey of research carried out in the past and by highlighting the relevant research problems of the present and of the foreseeable future. It is hoped that this overview will provide some background and continuity to new research workers in this field; and should help define priorities and direction for future research.

1. INTRODUCTION:

Research problems in Hydraulic Engineering in Trinidad and Tobago are varied and many. Some of these problems have been studied in the past, albeit partly. To the best of the author's knowledge, however, an overview of what has been accomplished to-date and what remains to be accomplished, in the field of Hydraulic Engineering research in Trinidad and Tobago, is not yet available. Such an overview, it may be noted, is essential for providing a background and continuity to new research workers in this field and also for defining priorities and direction for future research.

This paper attempts to provide such an overview, by means of a survey of research carried out to-date and by highlighting the relevant research problems of the present and of the foreseeable future. It is to be noted that the list of research work surveyed and, problems outlined in this paper are by no means complete and therefore the present effort should be considered only as a first step in this direction.

2. RESEARCH PROBLEMS:

The research problems in hydraulic engineering in Trinidad and Tobago can be divided into two broad categories; namely Coastal Engineering and Water Resources Engineering.

2.1 Coastal Engineering:

The coastal engineering problems can be sub-divided into three (3) groups as shown in Figure 1. The first group of problems relates to coastal protection. In this group the problem of beach erosion has been studied in considerable detail [1, 2, 3]. An important problem of future in this area is related to the provision of protected harbours for fishing along the north and east coasts of Trinidad. The design of such harbours would require, inter alia, a better understanding of the wave climate, which is influenced by the meteorological factors, ocean currents and physiographic features of the coastline [4, 5]. In particular, an accurate estimation of the characteristics of design waves of large return periods would be one of the prime requirements for engineering design [2, 6]. Thus in-situ measurements, hindcasting and statistical analysis of wave data as well as modelling, physical and mathematical, of harbours along the north and east coasts of Trinidad constitute the central problems of the foreseeable future in the field of coastal protection.

The second group of problems in Coastal Engineering relates to the silting of the existing harbours at Port of Spain and Point Lisas. In the case of Port of Spain harbour preliminary study was carried out in the early sixties [7]. This study defined the broad features of silting problem in Port of Spain harbour. However the basic problem of studying the silting pattern, as influenced by ocean currents in the Gulf of Paria [8], with a view to delineate navigation channel, which would require minimum maintenance dredging, remains univestigated.

The third group of problems in Costal Engineering refers to the scientific management of the nation's esturaries. The problems of land reclamation and agriculture in the Caroni, Nariva and South Oropouche swamps have hitherto been given only preliminary attention [9]. It is significant to note that a proper management of estuaries is essential

not only for land reclamation and agriculture but also for reducing the flooding problems in the lower reaches of the Caroni, Nariva and South Oropouche rivers [10]. Related to this problem is the rehabilitation and extension of the existing sluiced drainage system in these estuaries; and a finite difference approach, for determining the capacity of sluiced drains [11], needs to be incorporated in the design of such rehabilitation/extension works. Furthermore, in view of the complexity of flow in estuaries, hydraulic modelling studies will be necessary for obtaining guidelines for scientific management of the same [12].

2.2 Water Resources Engineering:

The problems in Water Resources Engineering can be broadly divided into two (2) groups; namely River Mechanics and Engineering Hydrology as shown in Figure 2. Related to River Mechanics are two (2) main problems. The first relates to the examination of hydraulic feasibility of hitherto unexplored possibilities of small scale hydro-electric facilites in Tobago; especially in the light of current availability of microprocessor controlled inexpensive low head micro turbines in 10kw — 100kw range [13]. In particular the integration of small hydro-electric reservoirs with irrigation, cottage industries, flood control, fisheries and recreation offers fascinating possibilities both in Trinidad and Tobago. The second problem in River Mechanics relates to sediment transport. In this regard the major problem of local relevance is the determination of relative applicability and calibration of numerous equations of bed load transport [14, 15]. This is a pre-requisite for the design of stable river imporvement works and sediment traps needed in urban areas [16, 17]. Another problem of significance in River Mechanics is related to the emprical research needed to calibrate the internationally known interrelationships between the discharge and the channel friction for local alluvial channels [18].

Research problems in Engineering Hydrology can be sub-divided into two groups; namely surface water and ground water hydrology respectively . Figure 3 shows the research problems in Surface Water Hydrology. The first group of problems in Surface Water Hydrology refers to the stochastic generation of streamflows, for optimal operation of resrvoirs, using the well known Markovian property of such flows [19]. This problem is of interest since using modern operations research techniques, the existing Water Supply Reservoirs in Trinidad and Tobago can also be used for irrigation and flood control.

The second group of problems in surface water hydrology refers to the general hydrologic problem of rainfall/runoff correlation. The first problem in this group relates to the estimation of peak flood flows. In this area the problems of temporal and spatial distribution of design storms and infiltration paramaters are largely unexplored [20]. This presents a serious short coming in the design of drainage and flood control works in Trinidad and Tobago [21]. The local design practice consequently borrows heavily from North America/European practice; which is basically irrelevant to hydrometerology of the Caribbean. Inherent in the peak flood flow estimation is the fact that return periods of floods and their causative rainfall are not necessarily the same, as there are other factors involved. In this context research needs to be carried out, perhaps in a similar approach as that of the Flood Studies Report of the United Kingdom [22], for obtaining a relationship for a recommended storm return period to yield a flood peak of required return period. There is also a lack of coherent methodology for the estimation of design flood peaks which often results in the over or under design of drainage structures and conflict between the Consulting Engineer and the approving agencies. In this context it may be noted that further development of the approach of Multiple Level Hydrologic Analysis may provide some answers to the problem of metholology [23]. The hydraulic flood routing, based on kinematic wave propagation of flood wave, offers many advantages over the popular hydrologic routing based on Muskingum method; especially for small ungauged catchments in hilly terrain [24]. An evaluation of the advantages of this method, therefore needs to be carried out before its use can be recommended to the local design practice.

The second problem in the domain of general rainfall/runoff correlation relates to the Water Balance Study of Trinidad and Tobago. It is well established that such a study, which provides a quantification of water resource, is one of the basic requirements for a long term economic planning of a modern nation [25]. In this context it is to be noted that a Water Balance Study of Trinidad and Tobago was carried out in the late sixties [26, 27]. However, this study was limited in extent since parts of Trinidad (i.e. north-eastern sector) and most of Tobago were not included. Therefore there is a need to extend the Water Balance Study to the areas not originally covered. Also, results of previous Water Balance Study need to be updated in the light of large scale changes in Water-shed characteristics during the past fifteen years.

In the field of Groundwater Hydrology the basic problems, as outlined in Figure 4, relate to the study and control of sea water intrusion into the costal aquifers and the rehabilitation of a number of over-pumped aquifers [26, 27]. An assessment of operational procedures for halting sea water intrusion in the El Socorro aquifer in Trinidad has been carried out [28, 29], but much remains to be done especially in respect of other coastal aquifers in South West and

North West Trinidad. The application of the operation research based technique of conjunctive utilization of aquifers and reservoirs needs to be investigated, as a practical means of considerable promise, for the rehabilitation of over-pumped aquifers (30).

3. CONCLUSIONS:

The following conclusions emerge out of the foregoing survey of research problems in Hydraulic Engineering in Trinidad and Tobago.

(a) There is an urgent need for generating a systematic and sustained research effort in Hydraulic Engineering. Furthermore, development of adequate hydraulic modelling facilities are required for supplementing theoretical research.

(b) In Coastal Engineering the first order problem relates to the estimation of design wave characteristics of large return periods for the adequate design of coastal protection works and harbours for fishing and tourism industries.

(c) In Water Resources Engineering the central problems that need priority attention relate to spatial and temporal distribution of design storms, infiltration parameters, sediment transport studies and stochastic reservoir operations.

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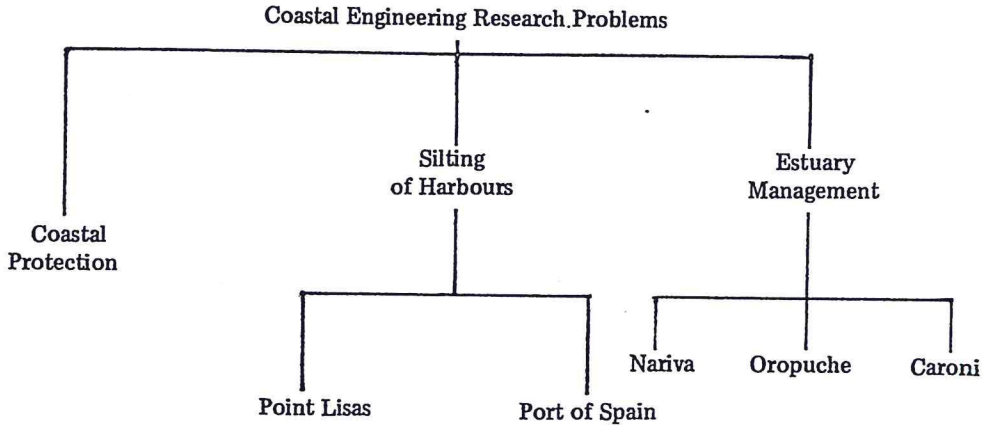

Figure 1. Coastal Engineering Research Problems

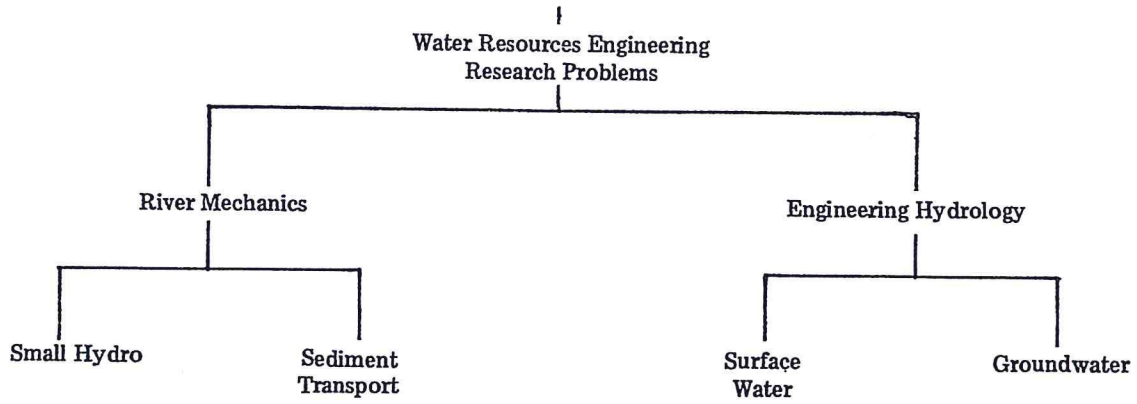

Figure 2. Water Resources Engineering Research Problems

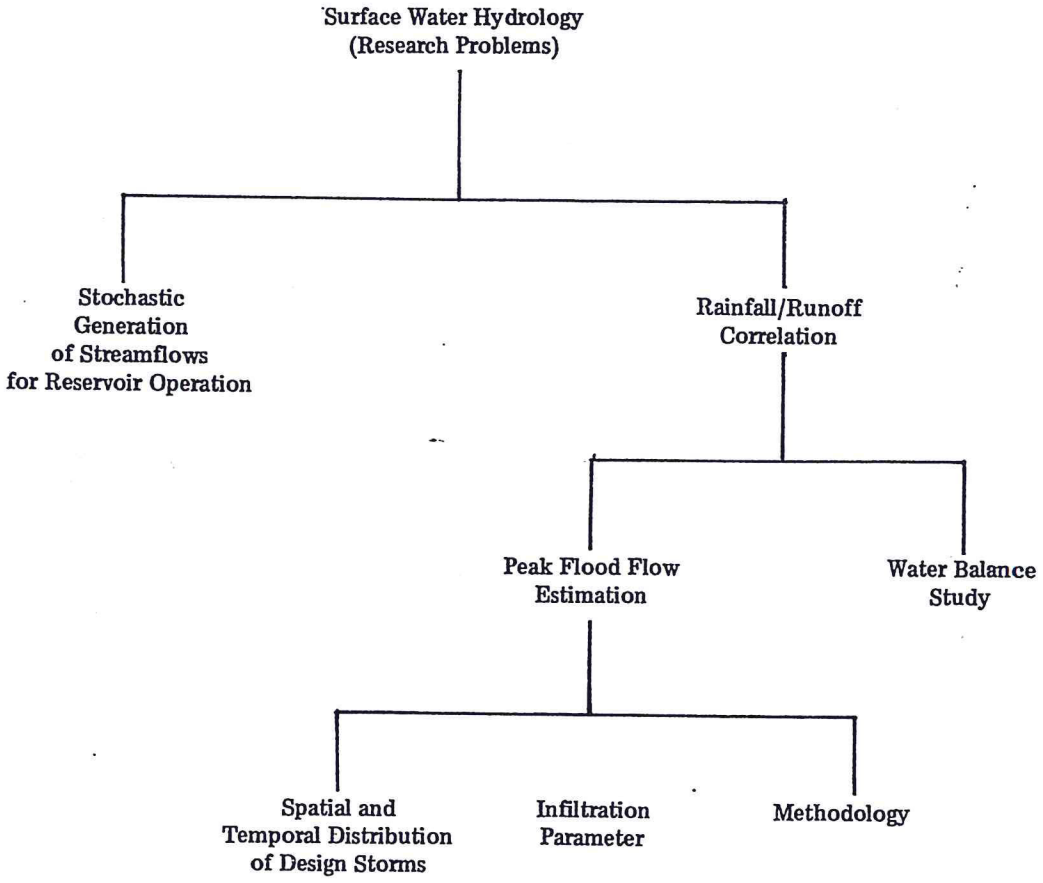

Figure 3. Surface Water Hydrology (Research Problems)

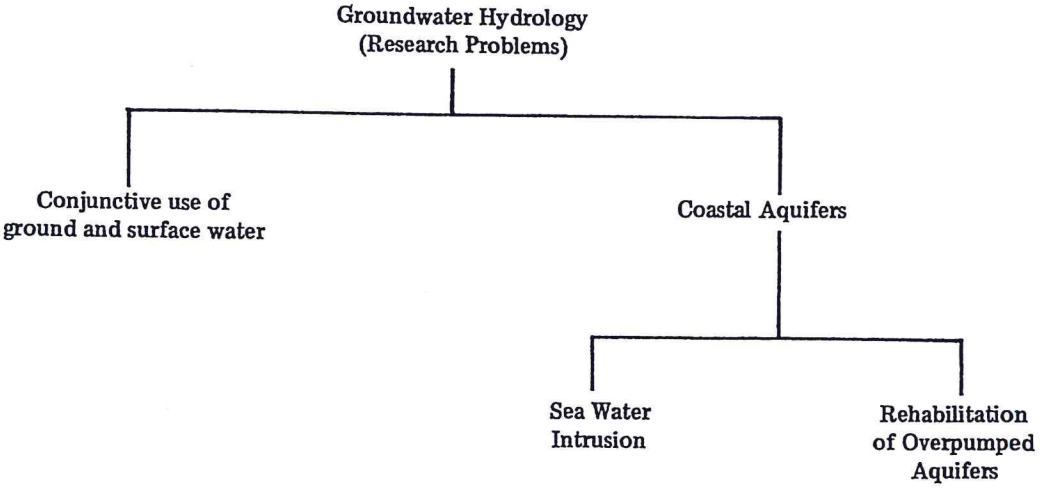

Figure 4. Groundwater Hydrology (Research Problems)