RESPONSE OF A PERIPHERAL WETLAND SYSTEM AT SINNAUPPODAI, BATTICALOA TO THE TSUNAMI TIDAL SURGE; AN EXPLANATORY SIMULATION MODELING APPROACH

NALLAINATHAN AMALRAJ, PARAMSOTHY JEYAKUMAR AND MANOHARADAS MANOBAVAN[1]

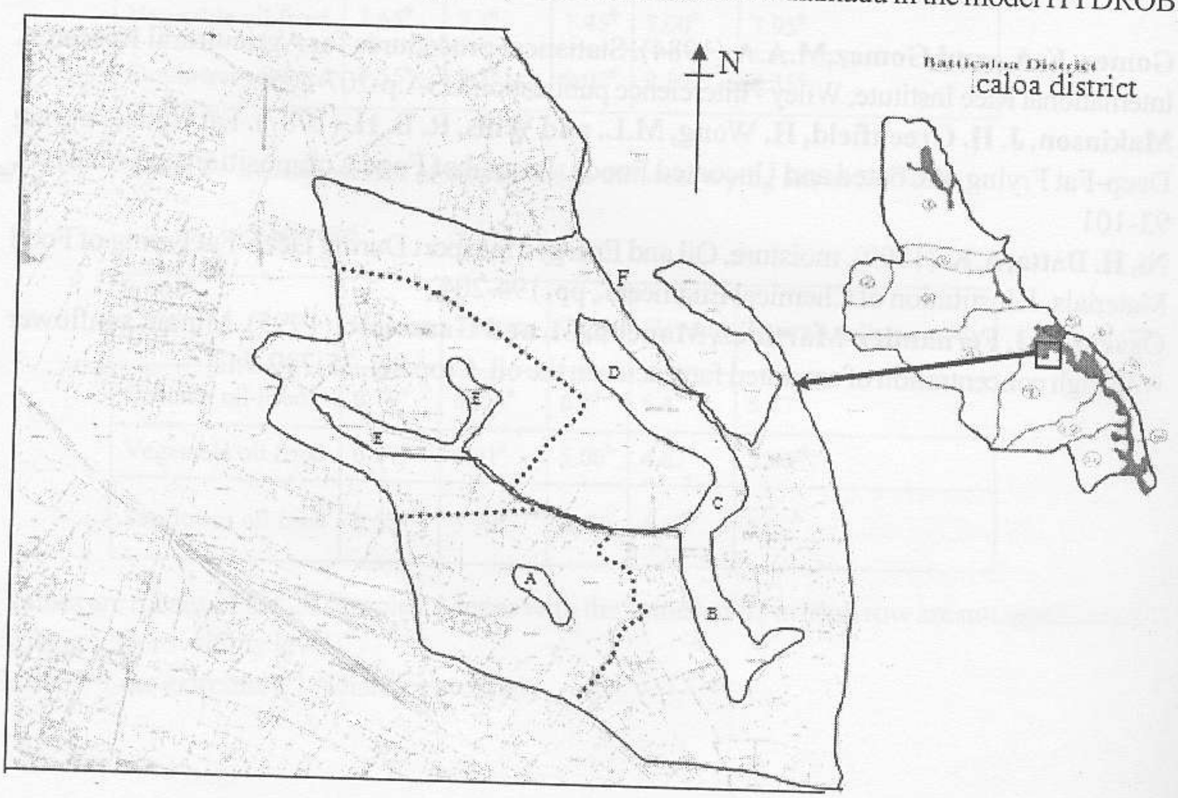
Division of Agricultural Engineering, Department of Agronomy, EUSL.

[1] Now at: North East Coastal Community Development Project North East Provincial Council.

1. INTRODUCTION

Wetland systems are natural coastal or inland geographical formations, which contain water at least for a major part of the year. Thus, they provide habitat for specific groups of plants at the place or in the surroundings. The presence of such systems plays an important role in the socio-environmental aspects of the locality. This paper focuses on the Sinnauppodai, part of the Batticaloa municipality. This affluent sub urban area has interconnected system of three important peripheral wetlands namely Sinnauppodai, Thamaraikeni and Kannamadu (see the figure 1 and 2).

In addition to the biological, Socio - environmental and socio-economic importance, these three peripheral wetlands are vital hydrological components for the locality as they play immense groundwater recharging and flood mitigating roles (Manobavan, 2003a; Manobavan and Jeyakumar, 2004). These recharging and flood mitigating potentials are explained by a conceptual model named as HYDROB 1 developed on the Ms Excel modeling platform. The figure 3 shows the simulated recharging capacity of the Sinnauppodai, Thamaraikeni and Kannamadu in the model HYDROB$_1$.



A- Kannamadu, B - Keeriodai, C- Sinnauppodai, D- Periyauppodai, E - Thamaraikeni,F- metticaloa Lagoon

Figrue. 1: Map of the Sinnauppoda drainage basin. The dotted line indicates the Sub basin boundary respective to each water bodies and the continuous line shows the boundary of entire basin

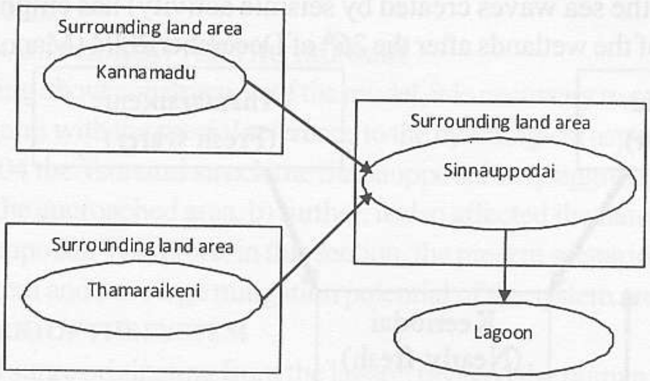


Figure 2: Simplification of the hydrological process in the area. The arrows show the channel connections between the sub basins (Developed by the authors).

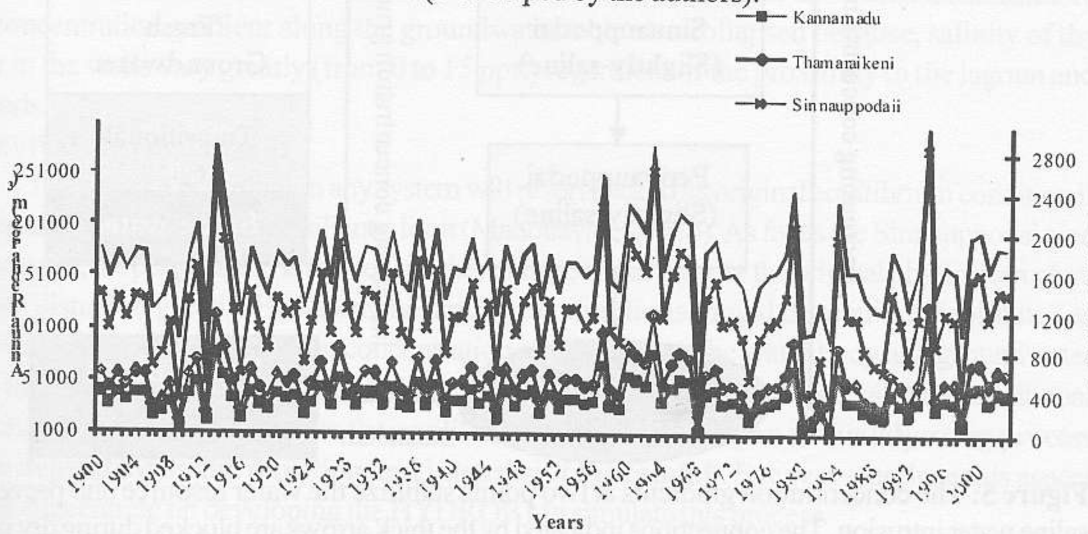


Figure 3: Simulated recharging capacity of the water bodies with respect to the rainfall on the model HYDROB 1

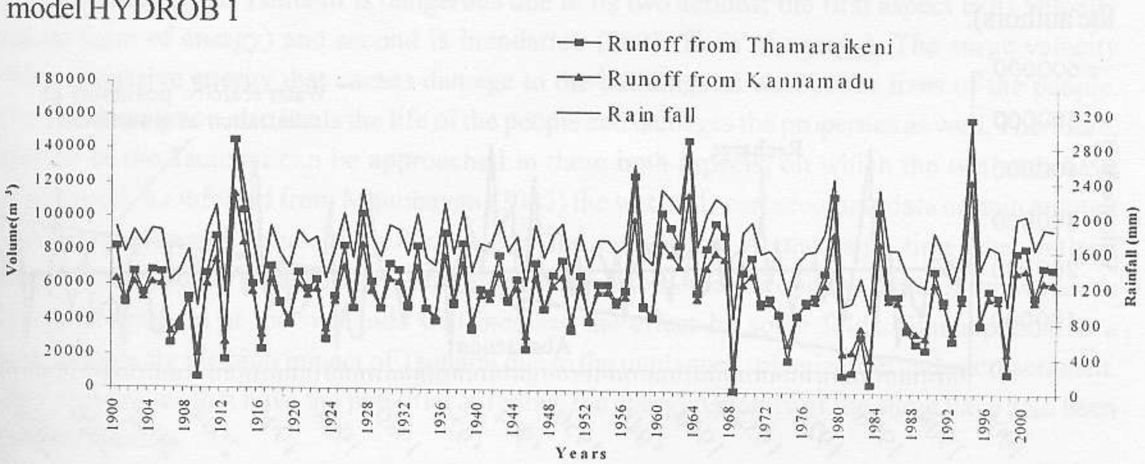


Figure 4: Temporal changes in surface run off and rainfall; simulated by the model HYDROB

Further, the flood-mitigating role is exhibited indirectly by the simulated runoff volume from the water bodies (Figure 4); **which means the tendency of the flood increases as the runoff increases**. Another important feature of this wetland system is the concentration gradient along the wetlands (Figure 5 and 6) that resists the salinization (Manobavan, 2003a).

Apart from the well-known benefits of the wetland system, the Tsunami (a word of Japanese origins that refers to the sea waves created by seismic activity) has emphasized the sea surge mitigation potential of the wetlands after the 26th of December 2004 (Manobavan, 2005).

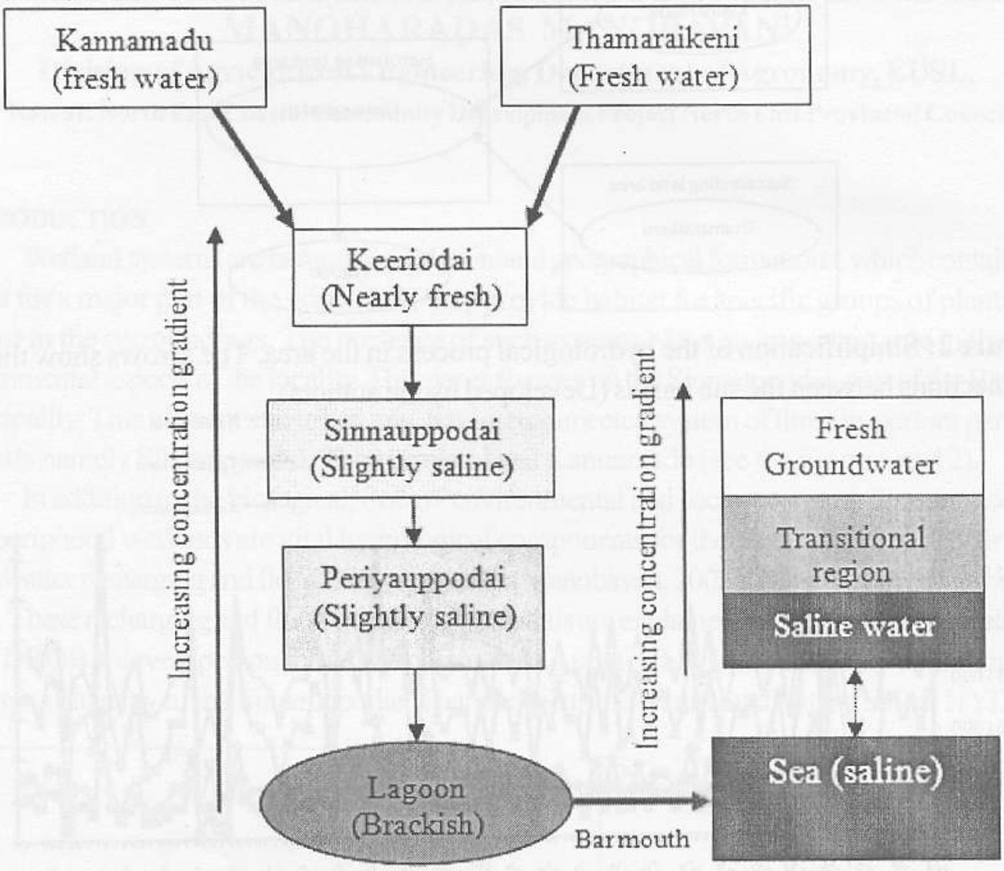


Figure 5: The concentration gradients at two points stabilize the water resource and prevent the saline water intrusion. The connections indicated by the thick arrows are blocked during dry period. The dotted arrow indicates the tele-connection[2] between the sea and groundwater (Developed by the authors).

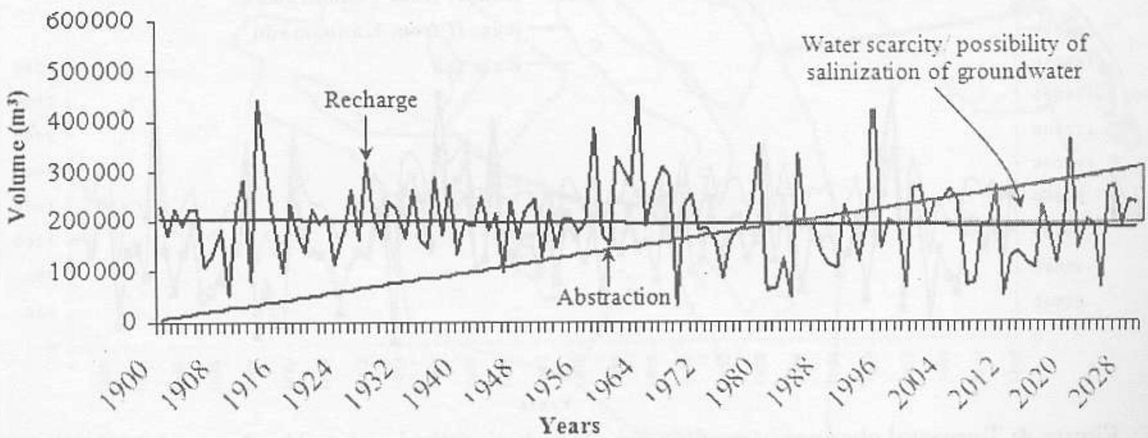


Figure 6: The simulated trend of reacharge and abstraction for the area of Sinnauppodai in the model HYDROB1.

Though this wetland system has the potential for the sea surge mitigation, the damage was indeed very high in Sinnauppodai because of the unplanned urbanization. This mismanagement indicates the necessity of the model that can estimate/indicate the dynamics of the flood plane not only during the Tsunami but also during heavy rain. In this regard, this paper explains the logical path towards constructing a model that can simulate the effect of Tsunami at Sinnauppodai using HYDROB 1 as the basis.

2. STATE OF THE SINNAUPPODAI AFTER THE TSUNAMI

Before thinking about construction of the model, it is necessary to examine the state of the system after the Tsunami with the special reference to the hydrological aspects. Because; a) on the 26th of December 2004 the Tsunami struck the Sinnauppodai very aggressively and ravaged the human dwellings at the encroached area, b) further, it also affected the natural equilibrium of the eco-system at Sinnauppodai. Therefore, in this section, the present scenario of the Sinnauppodai, the revival of the system and sea surge mitigation potential of the system are discussed.

2.1. PRESENT SCENARIO OF THE SYSTEM

The splashed surge originating from the lagoon ravaged the human dwellings, mangrove fringe and physical interconnection among the wetlands. Furthermore, the concentration gradient also has distorted which will lead to saline recharge[3] to the groundwater and increase salinization. The concentration gradient along the groundwater table also collapsed because, salinity of the water in the wells vary greatly (from 0 to 15 ppt[4]) regardless of the proximity to the lagoon and wetlands.

2.2. REVIVAL OF THE SYSTEM

Even after a perturbation any system will revert back to its original equilibrium condition if the perturbation is within the resilience limit (Manobavan, 2003b). As far as the Sinnauppodai area is concerned, the perturbation is not beyond the resilience limit because the original physical structure was not disturbed greatly. However, the drainage connections should be rebuilt/rehabilitated as they were. When considering the concentration gradient along the water body and groundwater table, the extensive rainfall received/experienced in the post Tsunami periods will be an additional support to bring the system back to the equilibrium. **The temporal span of this adjusting process is also dependent on the duration and intensity of the rainfall**. Future research on this aspect should concentrate on developing the HYDROB1 to simulate this process.

2.3. TIDAL SURGE MITIGATION ROLE OF THE WETLANDS (and associate peripheral wetlands)

The tidal surge/Tsunami is dangerous due to its two actions; the first aspect is its velocity (dynamic form of energy) and second is inundation (Static form of energy). The surge velocity contains a massive energy that causes damage to the buildings as well as for lives of the people. Further, the inundation also hauls the life of the people and damages the properties as well. Therefore, mitigation of the Tsunami can be approached in these both aspects, on which the wetlands have great potential. As inferred from Manobavan (2005) the wetlands can accommodate certain amount of splashed water and reduce the effect due to the inundation. At the same time, the wetland expands volumetrically and spatially. Therefore, human settlement along the bank of the wetlands and/or encroachment at the wetlands will increase the effect by some folds. Sinnauppodai is a typical example for the high impact of Tsunami due to the unplanned urbanization and encroachment. Further, mangroves that have the potential to reduce the energy/velocity of the surge have also been lost to urbanization.

3. CONCEPTUAL IDEA TO DEVELOP A MODEL FOR SIMULATING EFFECT OF TSUNAMI AT SINNAUPPODAI

From the significance of the wetlands at Sinnauppodai, it is obvious that the system needs a proper plan for the utilization of the system. Therefore, how a model can assist developing a plan is discussed by an explanatory modeling approach. As mentioned before, the model HYDROB 1 has the potential to predict recharging and flood mitigating capacity in quantitative terms. Both of these aspects are most important when considering the effect of Tsunami. Tsunami mitigating role of wetlands is very similar to the flood mitigation. Therefore, if any Tsunami forecasting model can estimate the surge volume, the excess surge quantity (after the accommodation by the wetlands) can also be estimated by HYDROB 1. Then if HYDROB 1 is coupled with Geographical Information System (GIS), the flood plane dynamics can be predicted effectively. Furthermore, as far as the recharging capacity is concern, after the collapse of the concentration gradient apart from the seawater intrusion or salinization, the ground water will be recharged by the saline water since the water bodies have saline water. In this regard, this concern needs a model for the concentration gradient coupled with HYDROB 1 (figure 7).

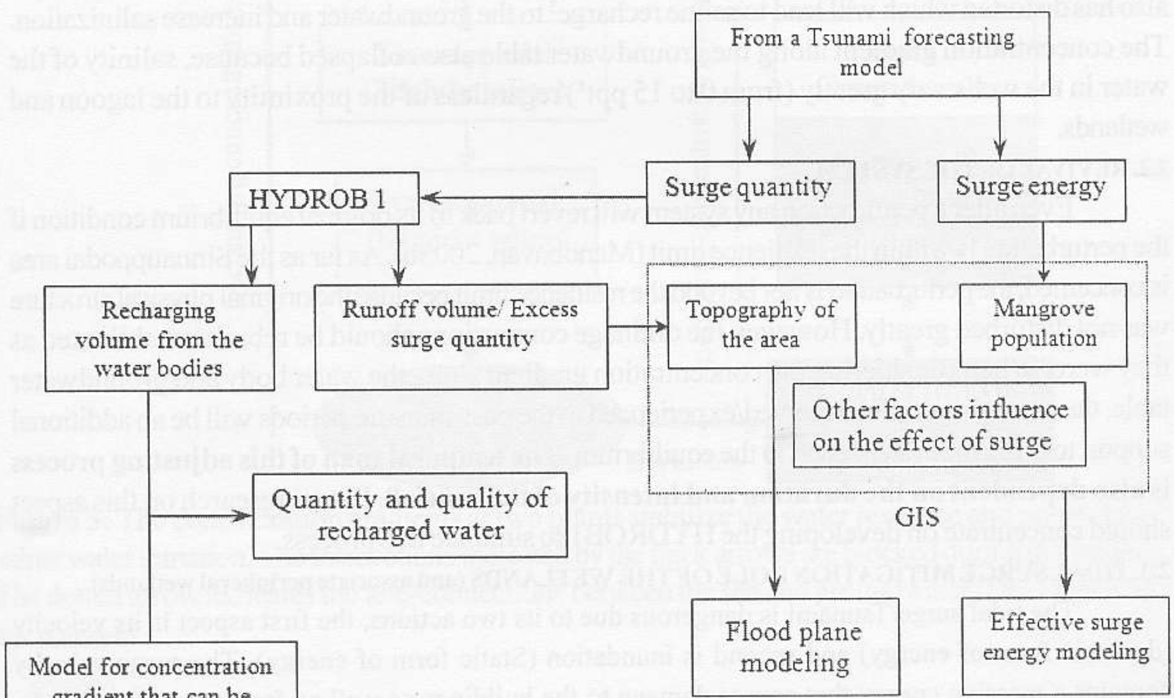


Figure 7: Logical frame of the model indicates the paths by which a model for effect of Tsunami at Sinnauppodai can be developed with the component of HYDROB 1 as a part of the model (developed by authors).

4. CONCLUSION

Though the Tsunami is a rare event, its effects cause remarkable perturbation in a natural system's dynamics, which needs long temporal spans to bring the system for its original equilibrium. However, when considering the Sinnauppodai drainage basin, the effect of Tsunami could have almost been avoided if the natural resources were planned properly. The proper plan needs the determination of the flood plane and the effective surge energy whilst the monitoring on the concentration gradient explains the temporal span required for the revival of the system. Construction of the human dwelling beyond the flood plane definitely will avoid the damage and loss. Further, the determination of the effective energy will be useful when a protection mechanism[5] is proposed. Apart from the planning perspectives, this concept paper explains the hydrological significance of the wetlands also.

FOOTNOTES:

1. It referens mainly the mangroves and mangroves associates
2. Indirect connection or connection through the soil mass
3. Stagnated saline warer will be added to the ground water through precolation - this phenomena is termed as saline.
4. This was measured during the field exoeriment conducted by the EUSL tow weeks after the Tsunami
5. Mangroves can also be planted as a protection mechanism

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