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Prioritization of sub watershed based on sediment production rate around Arasalar-Palavar division of Nagapattinam using GIS

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ABSTRACT

Sediment Production is one of the major problems in the Watershed areas. Based on this sediment production rate the area selected to study the Prioritization of the watershed was Arasalar-palavar watershed around Nagapattinam District. Finally, the disaster reduction model was suggested by using "JOSE and DAS" formula. To study this problem the Spatial Information Technologies like Geographic Information System and Remote Sensing were used. For the successful completion of this work, several scholars have extended their assistance and help and following are few to mention. The resource considerations for implementation of watershed management programs or various other reasons pertaining to administrative or even political consideration may limit the implementation to a few sub watersheds. Prioritization of watersheds is the ranking of different sub watersheds of a watershed according to order in which they have to be taken for treatment and soil conservation measures. Once the watersheds were prioritized, quantitative assessment such as peak flow and volume of runoff serve as basic information for adopting suitable soil and water conservation measures in a watershed. Hence, it is necessary to evolve suitable method for prioritizing watersheds. Watersheds are arranged in the ascending order or their sediment production rate and ranking was given in ascending order.

Key words: Watershed, Sub watershed, geo-hydrological, Sediment, soil fertility

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INTRODUCTION

Water is the key to life. It is one of the earth's most prominent resources, covering more than two-thirds of total surface area. Though it is a renewable resource, its importance as a finite, must be understood. Land and water use must be considered together, particularly in the context of recurring droughts and floods. Water, though a crucial component of the physical environment is generally, not available as and when it is required. Water management activities particularly in irrigation played a central role in the department of the earliest known river valley civilization. The National water policy adopted by Government of India focused the attention of this fact and states that, "Water is scarce and precious national resource to be planned developed and conserved as such and on an integrated environmentally sound basis keeping in view the needs of the states concerned".

With the development achieved in the last few decades and associated problems and the future needs, there is an urgency to look into critically whether the fields of Hydrology, Water resource management, Technology etc have appropriate answers to meet the future changes. The transport of detached sediment from the watershed areas of multipurpose dams, reservoirs, canals through the drainage network gives rise to appreciable loss of soil fertility, rapid sedimentation of the reservoir and decrease in available water for irrigation in command areas and it also is a disturbance at the mouth where the water mingles with sea.

Watershed: Definition and Basic Concepts

A watershed is defined as an area covered by the system of surface and sub surface water flowing into a common terminus for optimum utilization, conservation and equitable distribution of water resources. Watershed is either a geo-hydrological entity or an area, consisting of a set of geomorphologic units. This natural land is evolved through the inter-action of rainwater with landmass and typically compressed of arable lands, non-arable lands and natural drainage lands in rain fed areas.

Sub watershed

A sub-watershed is a smaller basin of a larger drainage area that all drains to a central point of the larger watershed.

Codification of Watersheds

The watersheds are codified for easy reference. In the codification of the watershed, the first numerical number refers the number of the watershed in a basin the capital letter (A, B, C.... etc) indicates the basin. The number (1, 2, 3...etc.) in the third place indicates the catchments. The capital letter in the fourth place indicates the sub-catchments. The number after sub catchments indicates the watershed. (Anon, 1993).

Watershed Management

A watershed management is defined as rational utilization of land and water resources for optimum and sustained plan with minimum hazard to natural resources. A watershed is the basic unit of development involving a manageable hydrological unit. It not only involves conservation, regeneration and judicious uses of natural resources, but also keeps a balance between demands of human needs and resources availability.

A comprehensive watershed management programmed may have multiple objectives such as controlling damaging runoff and managing and utilizing the same for useful purpose, controlling erosion and effective reduction in the sediment production, enhancing ground water storage and the appropriate use of the land and water resources in the watershed.

Watershed Management Practice

A watershed management practice is necessary that involves multidisciplinary activities. The management and development of watershed are of holistic approaches aiming to optimize the uses of accessable natural resources such as land, water and vegetation. This helps to alleviate drought, moderate floods, prevent soil erosion, improve water availability, and increase fodder, fuel and agricultural production on a sustainable basis.

Watershed management arrests sediment production, reclaims vast tracks of eroded lands, improves soil moisture, harvest rainwater, recharge of water and revives greenery. In due course of time, it restores rainfall, revives healthy climate, regenerates soil regime, and rejuvenates green foliage and environment.

Sediment Production Rate

The Sediment production rate is defined as the volume of sediment produced per unit drainage area per unit time. Sediment Production Rate (SPR) is useful in deciding the methods of soil conservation practice and for fixing the priority of watershed for adopting conservation measures.

Causes of Sediment Production

Sediment production due to natural phenomena is termed as geologic sediment production and if it is due to over exploration of land surface is called accelerated sediment production. Geologic sediment production of soil is caused primarily by the effect of rainfall, run-off topography, wind velocity, atmospheric temperature and gravitational forces. It is a continuous, slow but constructive process. In other hand, accelerated sediment production of soil is caused mainly by management errors such as rising of crops without adopting any soil conservation practices, deforestation etc. It leads to erosion in excess of the threshold value of the new soil formation, causing severe deterioration of the top surface of the land.

Factors Influencing Sediment Production

The important factors, which activate the sediment production process, comprises of climate, hydrology, geology, topography, soil type and vegetation. In addition to the above factors, the socio-economic condition and technical knowledge have a considerable effect on the rate of exploitation of land surface. Climate of the area, if it is hot and wind velocity is more; the fine soil particles are detached by the wind and transported to other places by means of suspension and saltation. Due to running of water also, the soil particles are detached and transported by suspension and saltation. Due to the temperature variation, the properties of soil are changed and they are under gone to geological actions. In India, it has been estimated that about 5333 Metric tones of soil is being detached annually due to various reasons. (Suresh. M, et al, 2004).

Effects of Sedimentation

Fine and coarse sediment transported by surface water can result in different types of problems. Fine sediment generally causes water quality problems both in channel and in receiving water bodies. In addition to this, turbidity concerns, other non- point source pollutants such as nutrients and heavy metals can form complexes with the clay minerals in fine sediment contributing to take eutrophication and toxicity to aquatic organisms that live in or feed on bottom sediments. Fine sediment also can occupy pore spaces in gravel soil, limiting permeability and reducing oxygen delivery to fish eggs deposited in the gravel.

In contrast, increased coarse sediment supply does not raise chemical concerns but can cause channel aggradations resulting in reduced flow capacity that can lead to flooding or navigational problems. It has a considerable effect on the rate of exploitation of land surface. Invariably these factors have a combined effect on soil erosion.

Literature Review

The transport of detached sediment from the watershed areas through the drainage network leads to appreciable loss of soil fertility, rapid sedimentation of the reservoirs and decreases in available water for irrigation in command areas. A study to prioritize watershed for treatment by assessing sediment production rate would aid for better planning of watersheds.

For assessing soil erosion (or) sediment production, several empirical models based on the geomorphologic parameters were developed in the part for quantifying the sediment yield (Misra et al, 1984; Jose and Das 1982). Chaudhary & Sharma (1998) performed erosion hazard assessment and prioritization based on morphometric parameters like relief ratio, drainage density, drainage texture and bifurcation ratio.

Garde and Kothari (1987) developed an empirical relationship involving catchment area, catchment slope, drainage density, vegetation cover factor and annual precipitation for average annual sediment yield estimation using a data of 50 catchments located in the plain region of India. Several methods such as Sediment Yield Index (SYI) method proposed by Bali and Karale (1977) and Universal Soil Loss Equivation (USLE) given by Wischmeter and Smith (1978) are used extensively in the prioritization of watersheds. (Suresh. M, et al, 2004).

Study Area Description

The mass production of paddy in Tamilnadu is from the Thanjavur and surrounding regions. The famous river of Tamilnadu “Cauvery” flows in this region. The first ancient watershed management system was started nearby the Thanjavur at Kallanai during Chola period by constructing check dam across the Cauvery. In a year, around four times agricultural works are carried out in this region from ancient time onwards and also contains coastal regions like Nagapattinam, Karaikal etc near by Thanjavur. The area considered for study is “Arasalar-Palavar Watershed (4BIA4)” which starts from Papanasam (Thanjavur district) and extended up to Sirkazhli (Nagapattinam district) along the mouth of Bay of Bengal and it is located in Cauvery delta region.

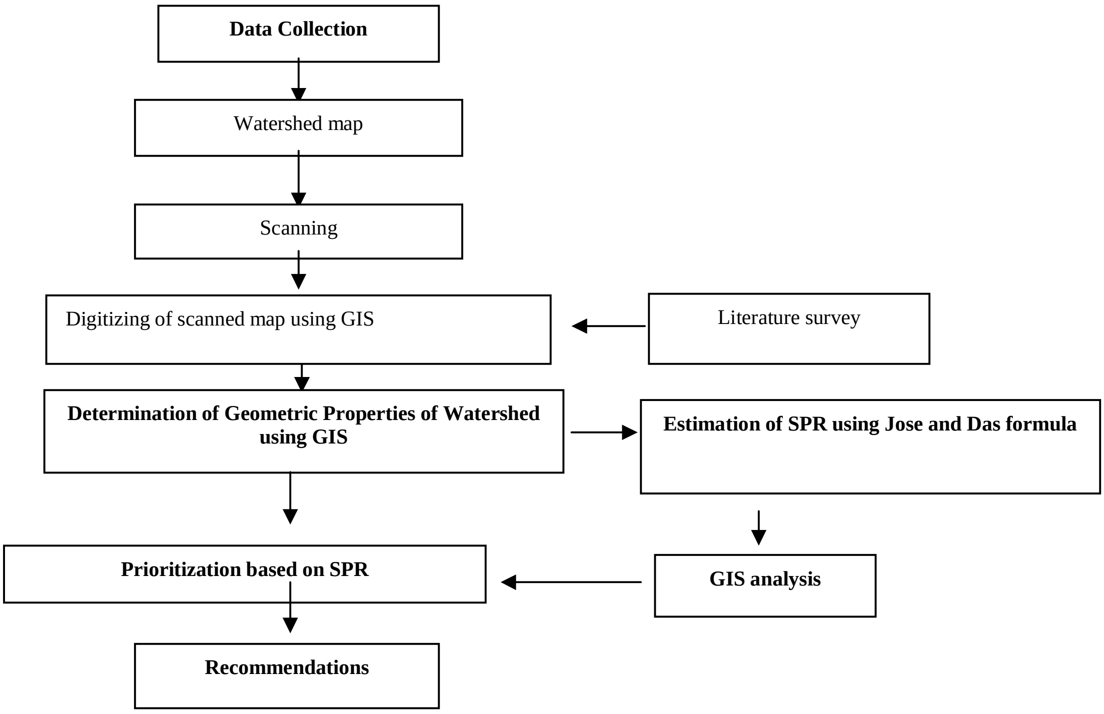
Objectives

The following are the objectives of this present study,

a. **To determine the geometric properties of sub-watersheds using GIS.**
b. **To estimate sediment production rate using Jose and Das Formula.**
c. **To prioritize the sub-watersheds based on Sediment Production Rateusing GIS.**

Method of Analysis
The adopted methodology has been explained below with the flow chart shown in flowchart.

Flow Chart Showing the Methodology Adopted in the Study



Analysis
The study area map was collected from IRS, Anna University, Chennai. This map was scanned and was converted in to Digital form using Arc GIS. Fig1: shows the study area map of Arasalar- Palavar division of Nagapattinam.. The Sub-watersheds (4B1A4a, 4B1A4b, 4B1A4c, 4B1A4d, 4B1A4e, 4B1A4f, 4B1A4g, 4B1A4h) of the main watershed (4B1A4) is shown in this figure**.**

The maps from **Fig 2** to **Fig 9** were prepared using SQL (Structural Query Language) process. This process is done based on the Sediment production rate (SPR) of every micro level watershed. The Sediment production rate is classified in to three classes. (i) Priority no 1, represents High SPR, (ii) Priority no 2, represents Moderate SPR and (iii) Priority no 3, represents Low SPR.

Fig 2: shows the prioritized areas of the sub-watershed 4B1A4a (Arasalar Kuttimanar division). 4B1A4a watershed consists of 12 mini Watersheds and 33 micro level watersheds. Out of these 33 micro level watersheds, 4 belong to the Class priority no 1, 21 belong to the Class priority no 2, 8 belong to the Class priority no 3.

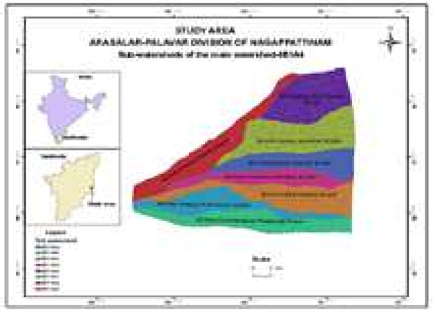


Figure-1

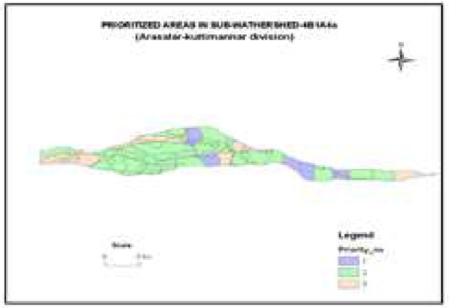


Figure-2

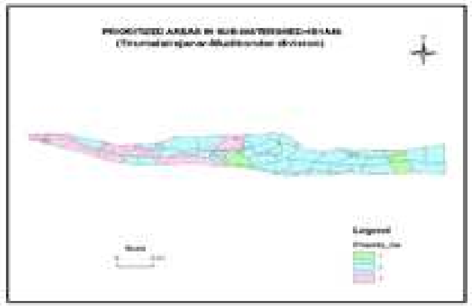
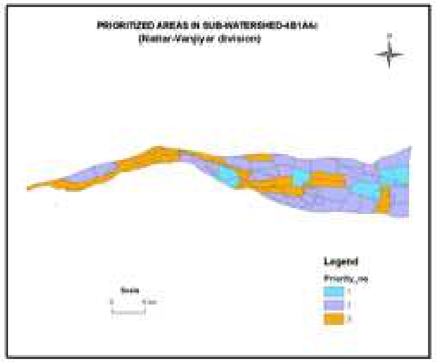


Figure-3



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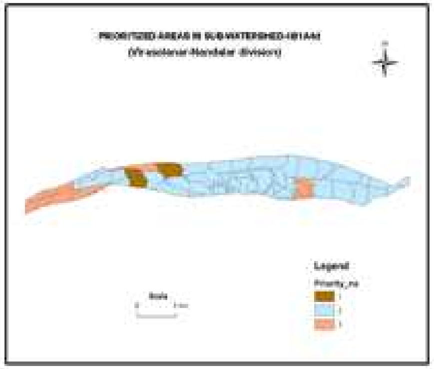

Figure-5

Figure-6

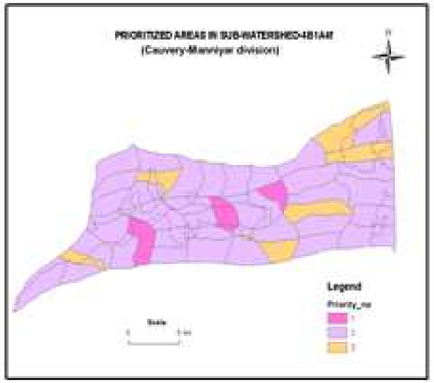

Figure-7

Figure-8

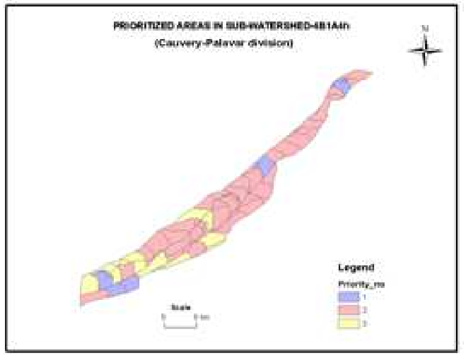

Figure-9

Fig 3: shows the prioritized areas of the sub-watershed 4B1A4b (Tirumalairajanar-Mudikondar division). 4B1A4b watershed consists of 13 mini watersheds and 35 micro level watersheds. Out of these 35 micro level watersheds, 3 belong to the Class priority no 1, 22 belong to the Class priority no 2 and 10 belong to the Class priority no 3. **Fig 4**: shows the prioritized areas of the sub-watershed 4B1A4c (Nattar-Vanjiyar division). 4B1A4c watershed consists of 14 mini watersheds and 43 micro level watersheds. Out of these 43 micro level watersheds, 5 belong to the Class priority no 1, 23 belong to the Class priority no 2 and 15 belong to the Class priority no 3. **Fig 5**: shows the prioritized areas of the sub-watershed 4B1A4d (Virasolanar-Nandalar division). 4B1A4d watershed consists of 11 mini watersheds and 30 micro level watersheds. Out of these 30 micro level watersheds, 2 belong to the Class priority no 1, 23 belong to the Class priority no 2 and 5 belong to the Class priority no 3. **Fig 6:** shows the prioritized areas of the sub-watershed 4B1A4e (Manjalar-Uppanar division). 4B1A4e watershed consists of 9 mini watersheds and 29 micro level watersheds. Out of these 29 micro level watersheds, 3 belong to the Class priority no 1, 23 belong to the Class priority no 2 and 3 belong to the Class priority no 3. **Fig 7:** shows the prioritized areas of the sub-watershed 4B1A4f (Cauvery-Manniyar division). 4B1A4f watershed consists of 15 mini watersheds and 45 micro level watersheds. Out of these 45 micro level watersheds, 3 belong to the Class priority no 1, 36 belong to the Class priority no 2 and 6 belong to the Class priority no 3. **Fig 8**: shows the prioritized areas of the sub-watershed 4B1A4g (Manniyar-Uppanar division). 4B1A4g watershed consists of 12 mini watersheds and 33 micro level watersheds. Out of these 33 micro level watersheds, 2 belong to the Class priority no 1, 28 belong to the Class priority no 2 and 3 belong to the Class priority no 3.

Fig 9: shows the prioritized areas of the sub watershed 4B1A4h (Cauvery-Palavar division). 4B1A4h watershed consists of 12 mini watersheds and 38 micro level watersheds. Out of these 38 micro level watersheds, 5 belong to the Class priority no 1, 26 belong to the Class priority no 2 and 7 belong to the Class priority no 3.

CONCLUSION

By this study, the sediment production rate of different watersheds of “Arasalar -Palavar watershed (4B1A4)” was determined by using Jose & Das formula. The sub watersheds were prioritized according to their sediment production rate.

Hence, all the Sub watersheds must be treated with some structural and suitable vegetative measures according to their priority levels. The prioritization must be given first to the Micro level watershed, which has high Sediment Production Rate. Small and medium gullies should be provided with detention dams to conserve the storm water and surface runoff and reduce the problem of floods.

Field leveling and grading of higher slopes into bench terraces and collection of runoff in small farm ponds (Popularly known as rainwater harvesting technique) helps in recycling water for raising agricultural crops. Rainwater harvesting not only alleviates soil erosion in the region but also directly addresses the temporal discontinuity between the availability of rainfall and crop moisture demand. Depending upon the inventories, it will be possible to suggest the kind of conservation and engineering structures required and proposed cropping system based on the water resources generated or sustainable use of natural resource like water, urgent need for environmental conservation and management of sub watershed through the participation of surrounding communities if necessary.

Check dams can stop flow of sediment to some extent in the watershed. Once it does not stop the production, the flow of sedimentation will slow down in the watershed for sometime. The socio-economic system of man in contrast to natural ecosystem is founded on a material base. The human beings impose changes on natural ecosystem and increasing control of his environment. In this study, a logical approach has been used successfully in prioritization of watersheds based on sediment production rate. This technique will be particularly useful, when data on the land use / cover, soil, slope information of the watershed is not available. In addition to the geometric map, land use/cover, rainfall data; water level data can also be used for specific recommendations.

REFERENCES

[1] Anon (**1993**). Watershed Atlas of India, Government of India.
[2] Bali. Y.P and Karale (**1977**),AHS-AISH Publication 222,pp.180.
[3] Chakraborti, A.K.(**1994**) *Journal of the Indian Society of Remote Sensing*, Vol.21, pp. 87-97.

[4] Chaudhary, R.S. and Sharma, P.D (**1998**). *Indian Journal of soil conservation*, 26(1), 6-11.
[5] Gilley et al., (**1988**) "Water Erosion Prediction Project Model (WEPP)".
[6] Johanson et al., (1**9**81) (HSPF) Model, watershed-scale model.
[7] Darcy K, Molnaar R (**1998**), *Computers & Geosciences* Vol. 24, No.2, pp. 183-192.
[8] Dhar, B.B (**1996**) Proceedings of the seminar (Abs) pp. 1-3.
[9] Garde, R.J. and Kothari, U.C (**1987**). *Journal for Irrigation and Power (India).* 44(3): 97-123.
[10] Jose, C.S and Das, D.C (1982), Proceedings, Nov4-6, **1982**. Vol.1pp15-23.