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# Soil erosion planning using sediment yield index method in the Nun Nadi watershed, India

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**Abstract**

The study identifies the extent of soil loss and proposes a method for prioritization of micro-watershed in the Nun Nadi watershed. The study used the Sediment Yield Index (SYI) method, based on weighted overlays of soil, topography, rainfall erosivity and land use parameters in 24 micro watersheds. Accordingly the values and thematic layers were integrated as per the SYI model, and minimum and maximum sediment yield values were calculated. The priority ranks as per the sediment yield values were assigned to all micro-watersheds. Then the values were classified into four priority zones according to their composite scores. Almost 14 percent area of three micro-watersheds (SW5b, SW6a and SW7b) showed very high priority; approximately 30.57 percent of the study area fell under the high priority zones. These areas require immediate attention. Conservation methods are suggested, and the locations of check dams are proposed after considering drainage, slope and soil loss.


*Keywords:* Check dam; Prioritization; Nun Nadi watershed; Soil loss; SYI

## 1. Introduction

Soil is one of the crucial natural resources that support life on the earth and controls the economic conditions of the nation. Soil erosion is a serious global problem that not only threatens sustainable agriculture but also ecosystems (Jain, Mishra, Surendra, & Shah, 2010). However, with rainfall erosion, the eroded soil moves downstream in the form of sediments. The amount of sediment load passing through the outlet of a watershed is known as sediment yield (Bhuyan, Marjen, Koelliker, Harrington, & Barnes, 2002)

The process of soil formation takes many centuries, but with rainfall erosion this can be negated in a few major storms, leaving soils residues that are degraded resulting in reduced yields. Soils erosion is common in all areas of the world, but developing countries suffer more because of the inability of their farming populations to replace lost

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soils and nutrients (Erenstein, 1999). Therefore, sustainable land management practices are urgently needed to preserve the production potential of land.

The efficient and optimum management and conservation of soil, land and water resources is best approached on a watershed basis. Normally, the amelioration processes are developed and applied following prioritization and landscape planning. Prioritization plays a key role in identifying areas that require attention (Kanth & Zahoor-ul, 2010). Watersheds are those areas from which runoff resulting from precipitation flows past a single point into a large stream a river, lake or an ocean. These are natural hydrologic entities that cover a specific aerial extent of land from which rainwater flows to a defined gully, stream or river of a particular point (Kumar & Kumar, 2011). The size of the watershed is dependent on the size of interception of the stream or river and the drainage density and its distribution. The drainage network helps in delineation of watershed for a particular river system. The Watershed Atlas of India published All India Soil & Land Use Survey, Ministry of Agriculture and Cooperation, Govt. of India (1990) has been referred for delineation from watershed to micro-watershed level.

There are several empirical models based on geomorphological parameters that were developed in the past to quantify sediment yield resulting from erosion. In addition, other methods such as Sediment Yield Index (SYI), developed by Bali and Karale (1977), and the Universal Soil Loss Equation (Wischmeier & Smith, 1978) are extensively used for prioritization of watersheds.

Chakraborti (1991) employed the SYI method for predicting sediment yield for prioritization of watersheds using remote sensing data. Similarly, Ratnam, Srivastava, Rao, Amminedu, and Murthy (2005) also employed the SYI model to analyze run off quantity, prioritize small watersheds and locate the check dam sites for the conservation of soil. Micro-watersheds are suitable for estimating sediment yield, prioritizing on the basis of sediment loss, and providing information for decision makers (Food and Agricultural Organization, 1987). However, by analyzing micro-watersheds in a GIS environment, results can be extrapolated for large areas. For instance, Mellerowicz, Ress, Chow, and Ghanem (1994) reported delineation of erosion prone areas and prioritization of micro-watersheds for a targeted and cost-effective conservation planning purpose.

Prioritized erosion and sediment yield data can also be used to locate check dams. Durbuda, Purandara, and Sharma (2001) suggested suitable site locations for check dams by studying run-off in part of the Mahi River. The study achieved the objectives of calculating the sediment yield index for soil loss estimation, prioritizing the micro-watersheds on the basis of sediment yield values and recommending the position of check dams and other conservation practices for soil conservation.

## 2. Study area

The Nun Nadi Watershed (NNWs) is a part of Yamuna river catchment. It extends between 30° 20′ 08″ to 30° 28′ 18″ N latitude and 77° 58′ 36″ to 78° 06′ 21″ E longitude and covers an area of about 8697.33 ha (Fig. 1). The watershed is located in the Doon Valley region, and according to previous studies approximately 20 Mg/ha/yr soil is removed, making it highly prone to soil erosion (Singh, Babu, Narain, Bhushan, & Abrol, 1992). The area has a sub-tropical climate with cold winters, warm and crisp springs, hot summers and a strong monsoon. It is surrounded by the Himalayas in the North. The average temperature of the study area is 20 °C approximately. The average annual rainfall of Dehradun station is 2073.3 mm, with about 87 percent of the annual rainfall in the area received during the months of June to September (July and August are the rainiest months). The variation in the rainfall from year to year in the area is appreciable. The average precipitation of Dehradun station in study area was 1554 mm in 2009 and recorded almost 3000 mm in 2013 ⟨http://en.tutiempo.net/climate/ws-421110.html⟩.

The study area includes the Dehradun and Mussorrie stations for rainfall data, but for better accuracy the neighboring stations viz. Nainital, Gopeshwar, Mandal, Garigaon, Lambgarh, Pandukeswar, and Joshimath were also marked as point layers, and were subsequently interpolated applying the Inverse Distance Weighted (IDW) method.

## 3. Data and methodology

The Survey of India (SOI) toposheets number 53F/15, 53J/2 and Landsat-TM image of October 2009 were the main sources of data for the study. Toposheets were used not only to delineate the watershed and micro-watersheds,