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REVIEW ARTICLE

Hydrological Approach through V-Notch Weir for Discharge Measurement in an Agricultural Land and Strategies to Mitigate Land Degradation

K. N. Singh[1*], Liansangpuii[2], A. Dalai[1], A. Dahate[1] and B. S. Rajawat[3]
[1]Department of Soil and Water Engineering, SVCAET & RS, IGKV, Raipur, Chhattisgarh, India
[2]Department of Agricultural Engineering, IAS, BHU, Varanasi, Uttar Pradesh, India
[3]PhD Research Scholar, Bundelkhand University, Jhansi, Uttar Pradesh, India
*Corresponding author-Email: knidhansingh@gmail.com

ABSTRACT
The terminology 'land degradation' is not being adequately inscribed, but is of crucial importance to raise awareness so that future land management decisions can lead to more sustainable and tough agricultural systems. Out of India's total geographical area (328.7 Mha), 304.9 Mha comprise the reporting area (degraded land) with 264.5 Mha being used for agriculture, forestry, pasture and other biomass production. The maximum soil eroded by the action of water, which is very harmful for agricultural land. Water erodes the top soil of land which minimized the nutrient and soil fertility. The V-notch is most suitable for erosion measurement through discharge analysis in which during discharge, some samples of water was collected in bottles and then it was kept in laboratory for sedimentation and after 15 days, soil loss was measured by appropriate method. The triangular-notch, thin-plate weir is a convenient, inexpensive, and relatively precise flow-measuring instrument, which is frequently used to measure the flow of water in laboratories and in small and natural streams. This report includes an extensive review of the literature and presents a comprehensive analysis of the discharge characteristics of triangular-notch. Previously published data are analyzed in the light of the effective-head concept, and a new discharge formula is proposed for discharge measurement in agricultural land. Coefficients are recommended and requirements for precise measurements are described along with limits of applicability. After indication of results suitable soil conservation practices should be adopted.
Key Words*: conservation practices, discharge, land degradation, soil erosion, V-notch*

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INTRODUCTION
Soil and water both the elements play an important role in agricultural production and also incomplete without each other. The production cannot be good if either one is deficient, in spite of this, most of the soil parts are eroded by water. Ultimate goal of water measurement is to conserve water through improving management of distribution and application. Attention to measurement, management, and maintenance will be an advantage of the farmer's water by preventing reduced yields and other crop damage caused by under or over watering [7]. Runoff and soil erosion are important hydrological parameters for any area as they give information about the amount of water available at the outlet of a catchment, storage potential of the area, amount of eroded soil [5]. Globally, 1964.4 Mha of land is affected by human-induced degradation [12].

SOURCES OF LAND DEGRADATION
Out of India's total geographical area (328.7 Mha), 304.9 Mha comprises the reporting area with 264.5 Mha being used for agriculture, forestry, pasture and other biomass production. According to the National Bureau of Soil Survey and Land Use Planning [8].146.8 Mha is degraded. Water erosion is the most serious degradation problem in India, resulting in loss of top soil and terrain deformation. Based on first approximation analysis of existing soil loss data, the average soil erosion rate was 16.4 ton $ha^{-1}year^{-1}$, resulting in an annual total soil loss of 5.3 billion tons throughout the country (Dhruvanarayan and Ram, 1983). Nearly 29% of total eroded soil is permanently lost to the sea, while 61% is simply transferred from one place to another and the remaining 10% is deposited in reservoirs. Soil degradation has become a serious problem in both rainfed and irrigated areas of India. Reddy, 2003 valued the loss of production

in India at Rs. 68 billion in 1988–1989 using the National Remote Sensing Agency (NRSA) dataset [9]. Overgrazing and deforestation have caused degradation in eight Indian states which now have >20% wasteland (Wasteland atlas of India by national remote sensing agency; NRSA). Pauperization of the natural woody cover of trees and shrubs is a major factor responsible for wind and water erosion. This occurs because the per capita forest land in the country is only 0.08 ha compared to a requirement of 0.47 ha to meet basic needs, thus creating too much pressure on forest lands.

CONTRIBUTION OF AGRICULTURAL ACTIVITIES IN LAND DEGRADATION

In India, most of the area continuously used under cultivation for hundreds of years and reached in an impoverishment stage. At the time of Green Revolution in India, 1967, a high technological breakthrough and use of short duration high yielding varieties were introduced, those helped intensify land use within a year by increasing the area under irrigation and greatly increasing the use of chemicals such as fertilizers and pesticides. After the adoption of Green Revolution strategies, agricultural production of India increased from 50 Mt to over 250 Mt, over the last five decades. Basically, degradation is caused by erosion, which results in the loss of topsoil through the action of water and wind, or waterlogging, which results in soil salinization.

Maheswarappa *et*. al., [6], observed that (i) the CSI (carbon-sustainability index) was high in 1960, and was indicative of the minimum usage of inputs prior to the onset of the Green Revolution and (ii) thereafter, the CSI decreased because of greater C-based inputs, in which a linear relationship exists between C inputs and C outputs. C based inputs include the amount of carbon emitted from electricity, fertilizers, seed production, pesticides, irrigation, limes and tillage practices while C based outputs include the crop production viz. grain yield, straw and other products in the form of biomass. Agricultural activities responsible for land degradation due to different ways such as land use, cropping pattern, crop rotation and management practices. Basically the common causes of land degradation by agriculture activities includes cultivation without conservation practices, clear cutting and land clearing, poor farming practices, overgrazing, over drafting, and irregular irrigation and its poor management.

DISCHARGE MEASUREMENT IN AGRICULTURAL LAND

Water is a scarce, limited and precious resource and one of the costliest inputs in agriculture and horticulture. Various techniques are available for measuring flow. Each one has its advantages and disadvantages, and selecting a proper technique depends on its specific applications. Pump capacities are usually measured with differential pressure type flow meters in case of small and medium size pumps. These flow meters are again needed to be verified for their discharges by volumetric or weirs or other methods. For large size pumps, however, the capacities cannot be measured with the above-mentioned flow meters because of their size limitations. In such cases, weirs are generally used for discharge measurements in agricultural lands at different cropping pattern system. A large number of empirical discharge formulas have been proposed for triangular-notch. Most of these were designed to fit a particular set of experimental data. None provides a comprehensive solution, even for a single liquid. Deficiencies in these formulas are concealed with numerous limits of applicability which greatly restrict their usefulness. This report presents a comprehensive analysis of the discharge characteristics of triangular-notch, thin-plated weirs. Previously published data from various sources have been reanalyzed, and some of the traditional discharge formulas are compared with an original solution. The report is based on one of a series of studies of weirs and spillways which was undertaken by the U.S. Geological Survey under the direction of C. E. Kindsvater. Previously published reports in the series are concerned with broad-crested weirs [11], rectangular, thin-plate weirs [4], and embankment-shaped weirs [3]. Portions of this report are adapted from unpublished reports and drafts of weir standards prepared by C. E. Kindsvater [4].

DESCRIPTION OF THE WEIR

The weir which is the focus of this study is a symmetrical, V-shaped notch in a vertical thin plate. The line which bisects the angle of the notch is vertical and equidistant from the sides of the approach channel. The weir plate is smooth, plane, and perpendicular to the sides as well as the bottom of the approach channel. The crest surfaces of the V-notch are plane surfaces which form sharp, right-angle corners at their intersection with the upstream face of the weir plate. The width of the crest surface varies, but it is generally between 1/32 and 1/16 inch. If the weir plate is thicker than 1/16 inch, the downstream edges of the notch are chamfered to make an angle of not less than 45° with the surface of the crest. Ideally, the channel upstream from the weir is straight, smooth, horizontal, rectangular, and of sufficient length to develop the normal (uniform flow) turbulence and velocity distribution for all discharges. Usually, however, it is less than ideal, and baffles or screens are provided in order to simulate a normal velocity distribution. Channel and tail water conditions at the downstream from the weir are such as to permit a free, fully ventilated flow from the notch. Provisions for ventilation ensure that pressure on the nappe surfaces is atmospheric. The tailwater is low enough that it does not interfere with the ventilation of the nappe or free flow from the notch. The head on the weir is the measured vertical distance from the water surface to the vertex of the notch. The head-measuring section is located at a sufficient distance in the upstream side from the weir to avoid the region of surface draw-down, and it is sufficiently close to the weir that the energy loss between the measuring section and the weir is negligible. A distance of 4 to 6 cm/m maximum head (h_{max}) is recommended. A V-notch or 90° notch is constructed as standard dimensions used for runoff estimation in agricultural land. The runoff or discharge is estimated by following formula,

$$\mathbf{Q = 1.417*H^{5/2}}$$

Where, Q = Runoff or discharge in m^3/sec,
H = Water Head in m

STRATEGIES TO MITIGATE LAND DEGRADATION

There are various measures to mitigate land degradation such as agricultural/agronomical practices, mechanical practices. Agricultural measures, such as bunding, contour ploughing, resizing cultivated land and minimizing slope according to topography can decrease erosion and slow runoff water velocity. Mechanical measures, e.g., physical barriers such as embankments and wind breaks, or vegetation cover (and use of vegetative buffer strips and geomembrane) and soil husbandry are important measures to control soil erosion [10]. Bunding minimize the runoff water velocity in agricultural lands with slopes ranging from 1%–6% slope. Bunds help to collect surface run-off, increase infiltration rate and prevent soil erosion. A study conducted at Doon valleys in the northwestern hills region indicted that contour bunds decreased runoff 25%–30% compared to field bunds [1]. Agronomical practices like use of cover crops, mixed/inter/strip cropping, crop rotation, green manuring and mulch farming are vital practices associated with integrated nutrient management. Growing soybean/groundnut /cowpea with maize (Sorghum)/bajra is a common example of intercropping in the dry lands [10]. Strip cropping is a combination of contouring and crop rotation in which alternate strips of row crops and soil conserving crops are grown on the same slope, perpendicular to the wind or water flow in dry lands and hilly regions, respectively.

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