Cause and effects of soil erosion environmental sciences essay

Environment, Ecology

The Latin word erodere, intending `` to gnaw away '' is the beginning of the word eroding ( Roose, 1996 ) . Soil Erosion is the physical remotion of surface soil by assorted agents, including falling raindrops, H2O fluxing over the dirt profile and gravitative pull ( Lal 1990 ) . The SoilScienceSociety of America defines eroding as `` the have oning off of the land surface by running H2O, air current, ice or other geological agents, including such procedures as gravitative weirdo '' (SCSA, 1982) . Physical eroding involves the withdrawal and transit of indissoluble dirt atoms (sand, silt and organic affair) . Removal of soluble stuff as dissolved substances is called chemical eroding and this possibly caused by surface overflow or subsurface flow where the H2O moves from one bed to another within the dirt profile (Lal 1990) .

Harmonizing to ASCE, 1975, the physical procedures in dirt eroding include withdrawal of dirt atoms, their transit and subsequent deposition of dirt deposits descent by raindrop impact and overflow over the dirt surface. Rainfall is the most of import detaching agent (Morgan and Davidson 1986 ; Lal, 1990) followed by overland flow in entraining dirt atoms (Lal 1990) .

The procedure of dirt eroding occurs in three chief stairss, withdrawal of dirt atoms, transit and deposition of dirt atoms downslope by raindrop impact and overflow over the dirt surface (ASCE 1975 ; Morgan and Davidson, 1986, Lal 1990) followed by overland flow in entraining dirt atoms (Lal, 1990) . Soil eroding reduces soil productiveness by physical loss of surface soil, decrease in rooting deepness and loss of H2O. In contrast dirt, dirt depletion means loss or diminution of dirt birthrate due to harvest remotion or remotion of foods by eluviations from H2O go throughing through the dirt profile (Lal, 1990) . Sedimentation nevertheless, causes off site effects like debasement of basins, accretion of silts in H2O reservoirs and entombment of low-lying productive countries and other jobs (Lal, 1990) . Sediments is the chief cause ofpollutionand eutrophication (Lal, 1990) . Harmonizing to Lal 1990, dirt debasement may be caused by accelerated dirt eroding, depletion through intensive land usage, impairment in dirt construction, alterations in dirt pH, leaching, salt accretion, construct up of toxic elelments such as aluminium or Zn, inordinate flood taking to cut down dirt conditions and hapless aeration.

Soil Erosion is the most serious and least reversible signifier of land debasement (Lal, 1977 ; El-Swaify, Dangler and Amstrong, 1982) . Soil eroding and dirt loss, harmonizing to Lal (1990) have inauspicious effects onagribusinessbecause they deplete the dirt 's productiveness and decrease the resourse base.

2. 2 Soil Erosion Process

Geologic eroding can be caused by a figure of natural agents including rainfall, fluxing H2O and ice, air current and the the mass motion of dirt organic structures under the action of gravitation which cause the disentangled or dissolved crude and stone stuffs to be removed from a topographic point and finally deposited to a new location (Lal, 1990 ; Morgan and Davidson, 1986) . The Soil Science Society of America (SCSA, 1982) described geologic eroding as `` the normal or natural eroding caused by geologic procedures moving over long periods and ensuing in the have oning off of mountains, the edifice up of inundation fields, coastal fields. Etc. '' The slow and constructive natural dirt eroding procedure has been significantly accelerated by human activities of hapless agriculture patterns, overgrazing, land glade for building, logging and excavation (Lo, 1990) . Accelerated eroding non merely affects the dirt but besides theenvironmentand is the primary cause of dirt debasement (Lal, 1990) . Agribusiness has been identified as the primary cause of accelerated dirt eroding (Pimentel, 1976) .

2. 3 Soil Characteristics in the Torrid zones

Extremes of clime and broad assortment of parent stuffs cause great contrast of dirt belongingss in the Torrid Zones from dirts in other temperate parts. In the Torrid Zones dirts are extremely variable and diverse like the flora (Sanchez and Buoi, 1975 ; Van Wambeke, 1992) . The chief dirt types are alfisols, oxisols, ultisols and inceptisols (El-Swaify, 1990) . Tropical dirts low in weatherable minerals and basic cations (Na, Ca, Mg, and K) resulted from uninterrupted weathering of parent stuffs (Lo, 1990) . The ability of these dirts to maintain works foods is mostly dependent on the humus content found in works biomass and the organic affair (Rose, 1993) . The inaction of dirt mineral components (china clay and sesquioxides) in these dirts, causes lack in harvest foods, lowers the capacity to retain basic cations, bounds active relationship with organic affair and overly immobilizes phosphates and related anions, a status which are extremely toxic to works roots (Lo, 1990) . Crop production in tropical dirts are constrained by chiefly aluminum- derived dirt sourness and sterility but by and large their physical belongingss are favorable (El-Swaify, 1990) . Tropic dirts have moderate to high permeableness under natural conditions, but susceptible to quenching and development of impermeable crust upon action of raindrops and as a consequence overflow additions with uninterrupted cultivation (Lal, 1982) . This crusting cause undistinguished decrease of filtration rate, increasing H2O overflow which leads to acceleration of dirt eroding (Falayl and Lal, 1979) .

It is of import to observe nevertheless that heavy and intense rains cause terrible eroding in the Torrid Zones (Morgan, 1974 ; Wilkinson 1975 ; Amezquita and Forsythe, 1975 ; Lal 1976 ; Aina, Lal and Taylor, 1977 ; Bois, 1978 ; Sheng 1982) .

2. 4 Soil Erosion on Steep Slope

Harmonizing to Lal 1990, Steeplands refer to lands with a incline gradient greater than 20 % . It is of import to observe nevertheless that level rippling lands have a great potency for harvest production and agricultural development. Due to the possibility of dirt eroding and the job of mechanisation, the steep countries are considered fringy for agribusiness production (Lal, 1990) .

The hard topography in steepland agribusiness restricts mechanisations of operations therefore, cut downing all agricultural activities (land readying, cultivation and harvest home) , restricting the husbandman in graduated table and efficiency. Input signals such as fertiliser and pesticides have to be carried manually by the husbandman. As a resulted they are used barely.

Perceptibly any addition in the usage of these agricultural inputs will ensue in diminution in he husbandmans net incomes from the by and large lower agricultural field (Benvenuti, 1988) . For all these grounds steepland husbandmans tend to concentrate in high value harvest production of limited graduated table (Ahmad, 1987 ; Ahmad 1990) . It is of import to observe nevertheless that husbandmans prefer steepslopes due to cultural manus cultivation, seting and reaping can be done in an unsloped manner (Williams and Walter, 1988) . Futher more subsistence husbandmans are found on steep inclines because of more favorable environmental conditions such as lower temperatures, reduced diseases and higher dependability of rainfall. (Hurni, 1988) .

In the Torrid Zones, remotion of forest flora causes inordinate leaching and accelerated dirt alimentary loss. Being extremely weathered dirt types, their contained minerals by and large have hapless ability to retain occluded foods against leaching. Clay soils with high residualmiron contents are considered superior in opposition to runoff caused dirt eroding ; therefore, dirts emanated from basic pyrogenic stones and ruddy dirts developed from chalky stones are strongly aggregated due to the cementing belongings of Fe oxides, hence, dirt eroding is expected to be less than for most other dirts. Besides soils developed from fragmental volcanic stuffs with andic belongingss are immune to dirty eroding (Sheng, 1986 ; Ahmad, 1987 ; Ahmad, 1990 ; Lal, 1990) . Soils formed from shales, schists, phyillites and sandstones are considered extremely erodible. Dirts produced from these stones are high in both sand or silt fraction, and clay minerals and Fe oxides are by and large deficient as cementing agents for a stable-structured dirt. These parent stuffs are by and large rich in Muscovite occurring in all dirt particle-size fractions. Micah-rich dirts are weak-structured, and therefore raindrops can easy free the weak sums, while the clay fraction dispersed in H2O. The ensuing isinglass flakes settling on their level axes in the H2O movie on the dirt surface causes dirt crusting. The formation of dirt crusts further restricts H2O entry into the dirt (Ahmad and Robin, 1971 ; Sumner, 1995) , ensuing to disposal of a much greater volume of overflow H2O, a status which leads to farther decomposition of dirt sums and conveyance of colloidal dirt stuff (Ahmad, 1987 ; Ahmad 1990) . Soil crust restricts gaseous exchange taking to anaerobic dirt conditions, denitrification, toxic effects due to ethylene production, and mechanical electric resistance to seedling outgrowth (Ahmad 1987 ; Ahmad, 1990) .

Steep incline cultivation can do certain instability in the ecological system with both onsite and offsite damaging impacts (El-Swaify, Garnier and Lo, 1987) . Soil, clime, land usage and farming systems affect the extent and the grade of badness of dirt eroding. However, irrespective of dirt and climatic conditions, intensively used steeplands in dumbly populated parts experience terrible dirt eroding job.

Land usage influences the grade of badness of dirt eroding on steeplands. Uncontrollable graze or over graze, exensive and opprobrious cultivation, diversified cropping are responsible for terrible dirt eroding in unprotected cultivable lands (Roose, 1988 ; Liao et Al 1988) . Ahmad (1987 ; 1990) reportd soil loss of about 120 t0 180 metric tons per hectare in Tobago

Trinidad. In Australia, one-year dirt loss of 200 t/ha to 328 t/ha has ben reported from inclining sugar cane plantations in cardinal and north Queensland (Sallaway, 1979 ; Mathews and Makepeace 1981) .

There are two types of dirt eroding associated with the Caribbean part, land slipping and gullying. Land slipping is a manifestation of mass motion associated with steepland agribusiness and the badness being strongly influenced by the parent stuffs. Land glade (illustrationdeforestation) and harvest production can act upon land stealing peculiarly in the early part of the moisture season when the cleared dirt moistures faster due to impregnation of the dirt above stone. Serious disruptions, harvest loss and devastation of any mechanical anti eroding devices can ensue from this signifier of mass motions. Due to drastic alterations in hydrological conditions experienced by land of course prone already to stealing and cleared for agribusiness for the first clip land slippage would be of common experience (Ahmad 1987 ; Ahmad 1990) .

Gullying is another common signifier of dirt eroding that occurs on steep land bcause of the terrain involved. This is more common on flaxen dirts, volcanic dirts and vertisols, which are all porous stuffs. Soils easy attain concentrated conditions upon the rapid entry of H2O, accordingly interrupting the stuff and finally, taking to the formation of gullies. Agricultural activities enables this dirt eroding in steeplands by leting rapid dirt wetting upon the start of the moisture season. Farming activities though inappropriately oriented field boundaries, pes paths and the deficiency of proviso for disposal of surface

H_2O are some chief causes of gullying, even on dirts non prone to this tpe of steepland dirt eroding (Ahmad 1987 ; Ahmad 1990) .

Since steeplands are traditionally considered fringy for agricultural harvest production, most research on dirt eroding and dirt preservation has been done on either level land or ' rolled land with a maximal incline of approximately 20 % ' (Lal, 1988) .

2. 5 Factors Affecting Soil Erosion

The causes of dirt eroding have been intensively discussed during the past 40 old ages. Soil eroding is a natural procedure that is enhanced by human activity (Richter, 1998) and occurs in all landscapes and under different land utilizations. In add-on to human activities, dirt eroding procedures are besides caused by morphometric features of the land surface, the erosive forces of rainfall and the erodibility of dirts and dirt surfaces.

When rainwater reaches the dirt surface it will either come in the dirt or run off. Runoff occurs when the rainfall strength exceeds the infiltration capacity of the dirt. Water eroding is the consequence of the scattering action of rain beads, the transporting power of H_2O and besides the exposure of the dirt to scattering and motion (Baver and Gardner, 1972) . The effects of dirt eroding is besides classified: definition of gullies and account of gully development is given by Morgan (1996) , every bit good as Hudson (1995) who to boot focuses on single instances of the development of gullies. Toy et Al (2002) give elaborate definitions of dirt eroding characteristics and procedures such as sheet eroding and inter-rill eroding, rill eroding, every bit good as passing and lasting gully eroding.

Rill erodibility depends both straight and indirectly on dirt belongingss such as majority denseness, organic C and clay content, clay mineralogy, cations in the exchange composite, dirt pH and experimental conditions such as wet content, aging of prewetted dirt and quality of gnawing H2O (Rapp, 1998) . Govers (1990) found that overflow eroding resisitance of a loamy stuff was highly sensitive to fluctuation in the initial wet content and to a lesser extent to alterations in majority denseness.

The procedure of H2O eroding can be separated into two constituents, rivulet and interrill eroding (Young and Onstad, 1978) . Interrill eroding (sheet eroding) is chiefly caused by raindrop impact and removes dirt in a thin about unperceivable bed (Foster, 1989) . In interril eroding the flow of H2O is by and large unconfined, except between dirt balls and screens much of the dirt surface. As the speed of flow increases the H2O incises into the dirt and rivulets signifiers (Evans, 1980) .

Rill eroding begins when the gnawing capacity of the flow at some point exceeds the ability of the dirt atoms to resistant withdrawal by flow (Meyer cited by Rapp, 1998) . Soil is detached by headcut progress from knickpoints (De Ploey, 1989 ; Bryan, 1990) , rill slide shedding and hydraulic shear emphasis (Foster cited by Rapp, 1998) every bit good as by slouching by underselling of side walls and scour hole formation (Van Liew and Saxton, 1983) . These procedures are normally combined into a withdrawal anticipation equation as a map of mean shear emphasis (Foster cited by Rapp, 1998) . When the rivulets develop in the landscape, a three to five fold addition in the dirt loss commonly occurs (Moss, Green and Hutka 1982 and Meyer and Harmon1984) .

2. 5. 1 Vegetative Factors

The effects of flora can be classified into three catergories:

The interception of raindrops by the canopy (D'Huyvetter, 1985) . Two effects are associated with this. First, portion of the intercepted H2O will vaporize from the foliages and roots and therefore cut down overflow. Second, when raindrops strike the flora, the energy of the beads is dissipated and there is no direct impact on the dirt surface. The interception per centum depends on the type of harvest, the growing phase and the figure of workss per unit country.

A well distributed, near turning surface vegetive screen will decelerate down the rate at which H2O flows down the incline and will besides cut down concentration of H2O (D'Huyvetter, 1985) . As a consequence, it will diminish the erosive action of running H2O.

There is besides the consequence of roots and biological activity on the formation of stable aggregrates, which consequences in a stable dirt construction and increased infiltration that reduces overflow and decreases eroding (D'Huyvetter, 1985) . Increased permeableness besides reduces eroding as a consequence of in increased H2O infiltration due to better drainage. Stables aggregrates in the surface soil besides counteract crusting.

2. 5. 2 Rainfall Factors

Raindrop size, form, continuance of a storm and weave velocity interactions controls the erosive power of rainfall (D'Huyvetter, 1985) . The erosivity of rainfall is expressed in footings of kinetic energy and is affected by assorted factors.

Harmonizing to Wischmeier and Smith (1965) , the strength of rainfall is closely related tot vitamin E kinetic energy, harmonizing to the arrested development equation

$$E = 1.213 + 0.890 \log I$$

Where

E = the kinetic energy (kg. m/m2. mm)

I = rainfall strength (mm/h)

Raindrop size, distribution and form all influence the energy impulse of a rainstorm. Laws and Parson (1943) reported an addition in average bead size with addition in rain strength. The relationship between average bead size (D50) and rainfall is given by:

D50: 2. 23 I 0. 182 (inch per hr) .

The average size of rain beads increases with low and average strength autumn, but declines somewhat for high strength rainfall (Gerrard, 1981) . The kinetic energy of an rainfall event is besides related to the speed of the raindrops at the clip of impact with the dirt (D'Huyvetter, 1985) . The distance through which the rain bead must fall to keep terminal speed is a map of bead size. The kinetic energy of a rainstorm is related to the terminal speed harmonizing to the equation:

Ek = IV2/2

Where Ek = energy of the rain storm

I = Intensity

V= Velocity of raindrop before impact

Ellison (1945) developed an equation demoing that the relationship between the dirt detached, terminal speed, bead diameter and rainfall strength:

E = KV4. 33 d1. 07 I0. 63

Where E = comparative sum of dirt detached

K = dirt invariable

V = speed of raindrops (ft/sec)

vitamin D = diameter of raindrops (millimeter)

I = rainfall strength

2. 5. 2. 1 Effect of rainfall strength on overflow and dirt loss

Harmonizing to Morgan (1995) , soil loss is closely related to rainfall partially through the detaching power of raindrops striking the dirt surface and the part of rain to runoff. If rainfall strength is less than the infiltration capacity of the dirt, no surface overflow occurs and the infiltration rate would be the rainfall strength (Horton, 1945) as sited by Morgan (1995) . If the rainfall strength exceeds the infiltration capacity, the infiltration rate peers the infiltration capacity and the extra rainfall signifiers surface overflow.

Harmonizing to Morgan (1995) , when the dirt is unsaturated, the dirt matric potency is negative and H2O is held in the capillaries due to matrics suction. For this ground, under saturated conditions littorals may bring forth runoff really rapidly although their infiltration capacity is non exceeded by the rainfall strength. Intensity partly controls hydraulic conduction, increasing the rainfall strength may do conduction to lift so that although overflow may hold formed quickly at comparatively low rainfall strength, higher rainfall strengths do non ever produce greater overflow (Morgan, 1995) . This mechanism explains the ground why infiltration rates sometimes increase with rainfall strengths (Nassif and Wilson, 1975) .

2. 5. 3 Soil Factors

Harmonizing to Baver et Al, (1972) , the consequence of dirt belongingss on H2O eroding can be in two ways: First, certain belongingss determine the rate at which rainfall enters the dirt. Secondly, some belongingss affect the opposition of the dirt against scattering and eroding during rainfall and overflow.

The atom size distribution is an of import dirt belongings with respects to erodibility. Generally it is found that erodible dirts have a low clay content (D'Huyvetter, 1985) . Soils with more than 35 % clay are frequently regarded as being cohesive and holding stable sums which are immune to scattering by raindrops (Evans, 1980) . Evans besides stated that littorals and harsh loamy littorals are non easy eroded by H2O due to its high infiltration rate. In contrast dirts with a high silt or all right sand fraction are really erodible.

Erodibility of dirt additions with the proportion of sums less than 0. 5mm (Bryan, 1974) . Factors which contribute to aggregate stableness include organic affair content, root secernments, gluey gels formed by interrupt down of organic affair, the binding of atoms by sesquioxides and the presence of a high Ca concentration on the exchange sites of the colloids alternatively of a high Na content (D'Huyvetter, 1985) .

The deepness of eroding is determined by the dirt profile (Evans, 1980) . Harmonizing to Evans dirt skylines below the A skyline or plough bed are frequently more compact and less erodible. The texture and chemical composing of the sub surface skyline can besides hold an inauspicious consequence. Normally deep gullies can be cut if the parent stuff is unconsolidated. If immune bedrock is near the surface merely rills will develop. Soil rich in surface rocks are less susceptible to eroding (Lamb, 1950 and Evans, 1980) . Rocks protect the dirt against eroding and besides increase the infiltration of the streamlined H2O into the dirt.

The antecedent dirt wet and the surface raggedness are both regarded by Evans (1980) as of import dirt factors impacting eroding. The ability of a dirt to accept rainfall depends on the wet content at the clip of the rainfall event.

2. 5. 3. 1 Factors impacting aggregative stableness

Dirt construction is determined by the form and size distribution of sums. Aggregrate size and strengthe determine the physical belongingss of a dirt and its susceptibleness to breakdown due to H2O forces. Their stableness will hold a decisive consequence on dirt physical belongingss (Lynch and Bragg, 1985) . The chief binding stuffs giving stable sums in air dry province are the pasting agents in organic affair (Chaney and Swift, 1984 ; Tisdale and Oades, 1982) and sesquioxides (Goldberg and Glaubic, 1987) .

2. 5. 3. 1. 1 Aluminium and Iron Oxides

The dirt used by Kemper and Koch (1966) contained comparatively small free Fe, although it did lend to aggregrate stableness. Their informations show a crisp addition of free Fe from 1 to 3 % . Goldberg and Glaubic (1987) concluded that Al-oxides were more effectual than Fe-oxides in stabilising dirt construction. Al-oxides have a greater proportion of sub-micrometer size atoms in a sheet signifier as opposed to the spherical signifier of Fe-particles.

Shainberg, Singer and Janitzky (1987) compared the consequence of aluminum and Fe oxides on the hydraulic conduction of a flaxen dirt.

2. 5. 3. 1. 2 Organic Matter

Organic affair can adhere dirt atoms together into stable dirt sums. The stabilising consequence of organic affair is good documented. Little elaborate information is available on the organic affair content required to sufficiently beef up sums with ESP values greater than 5 or 7, and incorporating illite or montmorrillionite, so as to forestall their scattering in H2O (Smith, 1990) . High humus content makes the dirt less susceptible to the unfavorable influence of Na (Van den Berg, De Boer, Van der Malen, Verhoeven, Westerhof and Zuur, 1953) . Kemper and Koch (1966) besides found that aggregative stableness increased with an addition in the organic affair content of dirts. A maximal addition of aggregative stableness was found with up to 2 % organic affair, after which aggregative stableness increased really small with farther additions in organic affair content.

2. 5. 3 Slope Factors

Slope features are of import in finding the sum of overflow and eroding (D'Huyvetter, 1985) . As slope gradient additions, overflow and eroding normally increases (Stern, 1990) . At low inclines due to the low overland flow speeds, withdrawal of dirt atoms from the dirt surface into the H2O bed is due to detachment entirely (Stern, 1990) . Additionally, at low incline gradients, atoms are splashed into the air in random waies unlike the instance with steeply inclining land where down incline splash occurs (Watson and Laflen, 1985) .

As incline gradient additions, the ability for surface overflow to entrain and transport deposits increases quickly until the entrainment by the surface overflow becomes dominant lending to sediment conveyance (Stern, 1990) . Foster, Meyer and Onstad (1976) presented a conceptual theoretical account that showed that at lower inclines, interill conveyance determined eroding, while at steeper inclines, raindrop withdrawal determined it. Th unvarying bed features of sheet flow conveyance tend to be replaced by channels because of instability and turbulent flow effects (Moss, Green and Hutka, 1982) .

There are many empirical relationships associating dirt conveyance by surface wash to incline length and incline gradient. Zingg (1940) showed that eroding varied harmonizing to the equation:

S = X1. 6 tanB1. 4

Where S = dirt conveyance cm/yr

Ten = incline length (m)

B = incline gradient (%)

Surveies conducted by Gerrard (1981) , showed that plane and convex inclines did non differ significantly in the sum of dirt lost by surface overflow, but concave inclines were less eroded.

Some research workers such as Zingg (1940) and Mc Cool et Al (1987) indicated that dirt eroding additions exponentially with addition in slope gradient. The relationship is indicated after Zing (1940) by: Tocopherol = aSb where Tocopherol is the dirt eroding, S is the incline gradient (%) and a and B are empirical invariables. The value of B scopes from 1. 35 to 2. 0. The other relationship between eroding and incline gradient for inter-rill eroding is given by Mc Cool et Al (1987)

E = a wickedness B Q+C

Q is the incline angle in grades

A, B and C are empirical invariables.

However, even if the consequence of incline gradient on eroding is good recognized, several surveies indicate that the power relationship between incline gradient and dirt loss over predicts interrill eroding rate by every bit much as two or more times (Torri, 1996 ; Fox and Bryan, 1999) , and the relationship is better described as linear.

2. 8 Soil Erosion Impacts

2. 8. 1 Soil Physical Properties

Progressive dirt eroding increases the magnitude of dirt related restraints for harvest production. These restraints can be physical, chemical and biological. The of import physical restraints caused by eroding are reduced rooting deepness, loss of dirt H2O hive awaying capacity (Schertz et al 1984 ; Sertsu, 2000) , crusting and dirt compression and hardening of plinthite (Lal, 1988) . Erosion besides consequences in the loss of clay colloids due to discriminatory remotion of all right atoms from the dirt surface (Fullen and

Brandsma, 1995) . The loss of clay influences soil tilth and consistence. Exposed undersoil is frequently of monolithic construction and harder consistence than the aggregative surface dirt (Lal, 1988) .

Development of rivulets and gullies may alter the micro-relief that may do usage of farming machinery hard. Another consequence of eroding is that the manangement and timing of farm operations.

2. 8. 2 Soil Chemical Properties

Soil eroding reduces the birthrate position of dirts (Morgan, 1986 ; Williams et al. , 1990) . Soil chemical restraints and nutritionary jobs related to dirty eroding include low CEC, low works foods (NPK) and trace elements (Lal, 1988 ; Fullen and Brandsma, 1995) . Massy et Al (1953) reported an mean loss of 192 kilograms of organic affair, 10. 6 kilogram of N and 1. 8kg per hour angle on a Winsconsin dirts with 11 % incline. Sharpley and Smith (1990) reported that the average one-year loss of entire P in overflow from P fertilized water partings is tantamount to an norm of 15 % , 12 % and 32 % of the one-year fertiliser P applied to wheat, assorted harvest grass and peanut - sorghum rotary motion patterns severally. Researchers (Massy et al 1953 ; Lal, 1975) have besides reported extended loss of N in scoured deposits.

2. 8. 3 Productiveness

Quantifying the effects on harvest outputs is a hard undertaking. It involves the rating of interactions between dirt belongingss, harvest features and clime. The effects are besides cumulative and non observed until long after accelerated eroding begins. The grade of dirt eroding 's effects on harvest output depends on dirt profile features and direction systems. It is hard to set up a direct relationship between rates of dirt eroding and eroding induced dirt debasement on the one manus and harvest output on the other (Lal, 1988) .

It is good known that dirt eroding can cut down harvest outputs through loss of foods, structural debasement and cut down of deepness and H2O keeping capacity (Timilin et al, 1986 ; Lal, 1988) . Loss of production in scoured dirt further degrades its productiveness which in bend accelerates soil eroding. The cumulative consequence observed over a long period of clip may take to irreversible loss of productiveness in shoal dirts with hard-boiled plinthite or in dirts that respond to expensive direction and extra inputs (Lal, 1988) .

2. 8. 4 Off Site Effects of Soil Erosion.

Effectss of eroding include siltation of rivers, harvestfailureat low lying countries due to deluging, pollution of waterbodies due to the assorted chemicals brought by the overflow from different countries. Several surveies reported the significance of the off site effects of dirt eroding on land debasement (eg. Wall and ven Den, 1987 ; Lo, 1990 ; Robertson and Colletti, 1994 ; Petkovic et Al, 1999)

Rainwater washes off stuffs that originate from fertilisers and assorted biocides (antifungals, insect powders, weedkillers and pesticides) which are applied in big concentrations. They reappear in greatr measures in the hydrosphere polluting and polluting the H2O environment (Zachar, 1982 ; Withers, and Lord, 2002 ; Verstraeten and Poesen, 2002) . Chemical pollution of H2O chiefly by organic affair from farm Fieldss causes rapid eutrophication in waterways (Zachar, 1982 ; Zakova et Al, 1993 ; Lijklema, 1995) .

2. 8. 5 Soil Erosion Models

Modeling dirt eroding is the procedure of mathematically depicting dirt atom withdrawal, conveyance and deposition on land surfaces (Approaching et al, 1994) . Erosion theoretical accounts are used as prognostic tools for measuring dirt loss and undertaking planning. They can besides be used for understanding eroding procedures and their impacts (Approaching et al 1994) . There are three chief types of theoretical accounts, empirical or statistical theoretical accounts, conceptual theoretical accounts and physically based theoretical accounts (Morgan 1995, Approaching et Al 1994, Merritt et al 2003) . It is of import to observe nevertheless that there is no crisp difference among them.

2. 8. 5. 1 Physically Based Models

These theoretical accounts are based on work outing cardinal physical equations depicting watercourse flow and deposit and associated alimentary coevalss in a specific catchment (Merritt et al. , 2003) . They are developed to foretell the spacial distribution of overflow and deposit over land surfaces during single storms in add-on to number overflow and dirt loss (Morgan, 1995) . Physically based theoretical accounts are besides called procedure based theoretical accounts (Morgan, 1995) as they rely on empirical equations to find eroding procedures. These theoretical accounts use a peculiar differential equation known as the continuity equation which is a statement of preservation of affair as it moves through infinite over clip. The common physically based theoretical accounts used in H2O quality surveies and eroding include: The Areal Non-Point Source Watershed Environment Response Simulation (ANSWERS) (Beasley et al. , 1980) , Chemical Runoff and Erosion from Agricultural Management Systems (CREAMS) (Knisel, 1980) , Griffith University Erosion System Template (GUEST) (Misra and Rose, 1996) , European Soil Erosion Model (EUROSEM) (Morgan, 1998) , Productivity, Erosion and Runoff, Functions to Evaluate Conservation Techniques (PERFECT) (Littleboy et al. , 1992) and Water Erosion Prediction Project (WEPP) (Laflen et al. , 1991) .

2. 8. 5. 2 Empirical Models

These theoretical accounts are based chiefly on observations and are normally statistical in nature. They are based on inductive logic, and by and large are applicable merely to those conditions for which the parametric quantities have been calibrated (Approaching et al. , 1994, Merritt et al. , 2003) . The chief focal point of these theoretical accounts have been in foretelling mean dirt loss although some extensions to sediment output have been developed (Williams, 1975 as quoted by Approaching et al., 1994) . Empirical theoretical accounts are by and large based on the premise that the implicit in conditions remain unchanged for the continuance of the survey period. They are non event responsive and disregard the procedure of rainfall - overflow in the countries being modeled. Empirical theoretical accounts are often used in penchant to the more complex theoretical accounts and are peculiarly utile as first measure in placing beginnings of deposit and alimentary coevalss (Merritt et al., 2003) . Among the normally used theoretical accounts are: The Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) , Revised Universal Soil Loss Equation (RUSLE) (Renard et al. , 1994) and the Soil Loss Estimation Model for Southern Africa (SLEMSA) (Etwell, 1978) .

2. 8. 5. 3 Conceptual Models

These theoretical accounts are based on on spatially lumped signifiers of H2O and sediment continuity equations (Lane et al. , 1988 in Approaching et al. , 1994) . They intend to include a general description of catchment procedures, without including the particular inside informations of procedure interactions which would necessitate elaborate catchment information (Merritt et al. , 2003) . These theoretical accounts can supply an indicant of the qualitative and quantitative effects of land usage alterations, without necessitating big sums of spatially and temporally distributed information. The chief characteristic that distinguishes these conceptual theoretical accounts from empirical theoretical accounts is that the conceptual theoretical account, whilst they tend to be aggregated, they still reflect the hypothesis about the procedures regulating the system behavior (Merritt et al., 2003) . The Agricultural Non-Point Source Model (AGNPS) (Young et al. , 1989) , Agricultural Catchment Research Unit (ACRU) (Schulze, 1995) , Hydrologic Simulation Program Fortran (HSPF) (Walton and Hunter, 1996) , and Simuator for Water Resources in Rural Basins (SWRRB) (Arnold et al. , 1990) are among the theoretical accounts (Merritt et al. , 2003) used in eroding and H2O quality surveies.

2. 7 Soil Erosion in the Caribbean

Soil Erosion in the Caribbean in chiefly affected by two types of factors, climatic factors and topographic factors. It can be seen that the dirts of the islands of the West indies should be capable to a great trade of eroding by H2O. The sum of dirt eroding happening in the Caribbean has non been quantitively determined. The badness of the eroding depends on topography, rainfall, natural flora, erodibility of the dirts, land usage and dirt direction.

Harmonizing to Breckner 1971, topographic effects are every bit utmost as the climatic effects. Several Caribbean islands are characterized by steep inclines with a high per centum (58 %) of the land country holding inclines greater than 30 grades. Many inclines are greater than 45 grades and agriculture is practiced on these inclines (Gumbs 1997) .

2. 7. 1 Trinidad

Erosion surveies on a scope of dirt types in many tropical states have shown that dirt losingss can be extended (Suarez De Castro 1951, 1952 ; Smith and Abruna 1985 ; Sheng and Michaelsen 1973 ; Lal 1976) . The earliest comprehensive study on dirt eroding in Trinidad was done by Hardy (1942) . He reported considerable gulling and sheet eroding in the foothills of the northern scope peculiarly in the western portion where intensive cultivation is carried out. Burning to unclutter the land for moisture season and landslides are common in some topographic points where the dirt is within six inches of parent stone. Besides harmonizing to Hardy sheet eroding is an of import in the Caroni field. He suggested that the dirt on the sides of the extremely cambered beds of the sugar cane countries is straight exposed to the rains and is therefore merely as prone to eroding as open dirt on steep hills of the northern scope.

In Las Lomas the sandy dirts are described as being really erodible. Since much of the land is a forest modesty, eroding is non a terrible job. In the cardinal scope land weirdo is a major job and the sothern inclines show many land slip cicatrixs. Chenery (1952) mentioned that Brasso clay, the most broad spread dirt of the cardinal scope is really scoured due to drawn-out cultivation. Both Hardy and Chenery commented on the terrible eroding of the marl soild and the associated ruddy dirts of the Naparima territory in southern Trinidad, with caps of open white marl being a common characteristic of the hills of the part.

Alleyne and Percy (1966) measured the dirt loss from the major dirt type (Maracas clay loam - orhoxic tropudult) in the northern scope under Ananas comosus (Ananas comosus) with 50 % of the country terraced and pangola grass (Digitaria decumbens) . Under both types of flora the overflow was less than 10 % of rainfall and the dirt losingss were both really little (& lt ; 0. 4 and 0. 05 metric tons per hectare during the moisture season) . Lindsay and Gumbs (1982) have shown that this dirt type is merely somewhat erosible but the big sums of dirt can be lost from the bare dirt (Gumbs and Lindsay 1982) .

Report on losingss of N by eroding either in overflow or eroded deposits are limited. Neal (1944) considered that the bulk of nitrogen loss by eroding occurs in the organic fraction of the dirt as H2O easy loosens and floats off organic affair. Lal (1976) found there was a inclination for greater losingss of inorganic N in the erosed deposits than in the overflow H2O.

2. 7. 2 Tobago:

Information on the eroding state of affairs in Tobago are Brown et Al (1965) , Hardy (1942) and Breckner (1971) . All the cragged countries of Tobago is extremely prone to eroding with dirts formed from such extremely erosive parent stuffs as diorite and schists ruling. Volacanic tufas and breccias make up the 3rd major type of prent stone. In the South of the island eroding becomes a more serious job. Hardy has described heavy eroding in the Castara - Parlat country on the leeward side of the island.

On the winward side of the island, big spots of land on the volcanic dirts are still being cleared, chiefly by firing and seting with cultivable harvests such as maize, land commissariats and tomatoes. The worst scoured country is in Mason Hall. - Les Coteaux territory. The flaxen clay loam dirts of this country formed from dioritein really irregular, steeply inclining topography look to be extremely erodible. This is due to the chief country sing provincial farming which involves intensive cultivation.

It is of import to observe nevertheless that brown et al estimated that between 1956 and 1965 1500 estates of land have been treated by dirt preservation steps under the subsidies strategy. The authour saw no grounds of treated land. It was observed that dirt preservation steps were practicised.

Limited dirt preservation is practiced chiefly in the signifier of intercropping and on occasion trash mulching (Gumbs 1997) .

2. 7. 3 Antigua:

The low rainfall and degree topography of much of both Antigua and Barbuda has meant that non as much eroding has occurred as in some other parts of the West Indies (Hill 1964 ; Vernon and Lang 1964) . However much accelerated eroding has occurred in the cragged countries of Antigua. Cotton was grown extensively and requires a long fallow period under hapless hapless direction. Monoculture of sugar cane in the yesteryear has besides added to the loss of much dirt in hilly countries. Harsh and Torrential rains occur frequently after long periods of drouths when vegetive screen is thin. This has contributed to the eroding job.

In the hills of the cardinal part, Indian Creek loam and Liberta clay loam are both described as being really eroded with parent stuff being exposed in some topographic points. In the south West mountains, frys clay loam and springhill loam, small dirt is left at all on the steeper slopes.

2. 7. 4 Barbados:

Harmonizing to Veron and Carroll (1966) about 25 % of Barbados occurs occupies comparatively level coral dirts on which eroding is non considered to be terrible. They suggested that eroding control measures, possibly necessary on the dirts of highland tableland of St. toilet 's Valley.

In the hilly Scotland District eroding is really terrible. Cumberbatch (1985) reported that it was estimated that 70 % of the country was threatened by eroding and that 11 % of it had reached a really terrible province of debasement. L andslides and gullying are common.

2. 7. 5 Dominica:

The dirts of Dominica are extremely permeable except dirts formed on pyrogenic stones, the shoal dirts and other dirts become less permeable during pedologic development. As a consequence non as much eroding occurs. Dominica is charaterised by steep inclines where 86 % of the land country has inclines greater than 20 grades and merely 2 % has slopes between 0 to 5 grades. Slopes of over 60 % with natural flora and cultivated inclines over 50 grades are reported by Lang (1967) , bespeaking that the dirt is of unusual stableness. It is of import to observe nevertheless that eroding is limited because much of the land is still under forest.

On the Leeward side of the island, most of the shoal dirts and other dirts of low permeableness occur. Poor dirt and harvest direction has been the major subscriber to the dirt eroding job. The slow regeneration of dirt suitable for cropping in he dry countries (as in St. Lucia besides) increases he strength of dirt eroding.

Harmonizing to the environment profile of Dominica prepared under the advice of the Caribbean Conservation Association in 1991, Dominica has great potency for agricultural development without damaging or remotion ofthe forestlands. Forestry and forestry development are of import. Timber extraction is undertaken but harmonizing to Russell (1974) it amendss merely a comparatively little country and the eroding caused is non important.

2. 7. 6 Grenada and Carriacou:

Harmonizing to Vernon et Al (1958) , although some terrible eroding can be seen in the hills where switching cultivation, atomization of land, hapless land distribution and hapless cultivation patterns exist, Grenada has suffered less from eroding and birthrate exhaustion than many of the Caribbean islands. There are two chief grounds for this ;

The island 's agribusiness is chiefly on tree harvests, chocolate (Theobroma chocolate tree) and nut million (Myristica fragrans) , banana an nutrient harvests are often interplante with chocolate ; and major wood fires are non prevailing.

The dirt parent stuff is really basal rich an the dirt has been farther enriched by add-ons of volcanic ash from eruptions in about islands in recent times. Even if some surface dirt is lost, the underlying open stuff is about as fertile and promotes raid vegetive growing.

Caribbean has suffered really terrible eroding over about the whole island and in many instances merely the parent stone remains. This has been as a consequence of the erodible nature of the dirt, unsustainable cultivation methods an overgrazing. The dirts of cariacou are skeletal dirts over ash and agglomerate dirts formed from other pyrogenic stones and those formed from limestone. They are all susceptible to eroding and deep gullies.

2. 7. 7 Monsteratt:

Lang (1976) describes the whole island as enduring from terrible dirt eroding and the greater part holding lost its top dirt. Unlike the dirts of Dominica, they are by and large unstable and many dirts are extremely erodible if cultivated on inclines greater than ten grades.

2. 7. 8 St. Vincent:

Harmonizing to Watson et Al (1958) dirt and land usage study of St. Vincent, he mentioned that because of certain types of harvests grown, dirt eroding is a serious job. The three harvests which contribute to much of the eroding are cotton (Gossypium sp.) , arrowroot (Maranta arundinacea) and land nuts (Arachis hypogaea) . Cultivation of these harvests disturb the dirt and go forth the dirt bare for long periods. Erosion can be seen in all but the flattest countries. It is of import to observe nevertheless that the husbandmans of St. Vincent are witting of the eroding job and dirt preservation methods are of high criterions.

2. 7. 9 St Lucia:

Soil eroding is a major job in St. Lucia. Many of the dirts inside are susceptible to heavy rains and dirt can be seen being washed off by even the smallest rills (Stark et al 1966) . In countries of allophonic clay dirts, slouching is a job and gullying besides is common throughout the island. Common patterns such as clean cultivation of really steep land and of uncluttering steeply inclining forested land which would be left under its original flora have accentuated the state of affairs. Probably the most terrible affecs of eroding are on the so called `` shoal dirts '' which contain a bed of indurated stuff in the substrate.

2. 7. 9. 1 St. Kitts and Nevis:

Information on dirt eroding on these two islands is taken from the dirt study study by Lang and Carrol (1967) Erosion in the cragged countries of the islands has much been reduced by conserving the country in wood. Where the wood has been cleared and planted to proviso harvests, some accelerated eroding is seen. The undersoil of most of the island 's dirts is free run outing and contour cultivation is common the worst effects of eroding are normally avoided. On the island of Nevis in contrast, much eroding can be seen. In much of the chief agribusiness countries the surface dirt has been lost wholly.

2. 7. 9. 2 Jamaica:

The dirt study studies of Jamaica (Barker, 1963 and 1970 ; Finch 1959 and 1961 ; Morgan and Baker, 1963 ; Price 1959a and 1959b ; Stark 1963, 1964a and 1964b ; Vernon, 1959 and 1960) indicate that dirt eroding is rampant in many parts and on many dirts of the island. One of the major factors is population force per unit area which consequences in increasing frequence and strength of land usage or the usage of land beyond its capableness. The parishes of Westmorland, Portland, Hanover, Clarendon and St. Elizabeth are particularly noted as enduring from terrible accelerated eroding. Soils where eroding is a serious job are limestone dirts, shale deriveds and the dirts formed on grano-diorite. Besides the shale dirt dirts are noted for their superficiality, hapless infiltration and permeableness, factors which contribute to serious