## Runoff Estimation In ArcGIS Using NRSC Curve Number Method

Tutorial



## Developed by Dr. Mahesh Kumar Jat

Email – <u>Mahesh.mnit@gmail.com</u> Phone – 01412713412; 09549654186

Department of Civil Engineering Malaviya National Institute of Technology Jaipur

## Rainfall Runoff Modelling Using NRCS-CN Method

# Key Words: Rainfall-runoff, NRSC-CN, Modelling, Hydrology, GIS, Remote Sensing

Problem: You have to estimate surface runoff using NRCS-CN method for Ajmer Area. You have been provided with DEM, Soil map, LULC map, Rainfall map and watershed map.

#### **Curve Number Method for Runoff Generation**

The Stream flow which is measured in a river consists of 3 components namely the surface runoff, sub-surface and ground water (base flow) components Fig 1. Mathematically it is possible to quantify these components individually. But remote sensing and GIS play a prominent role in quantifying only the surface runoff. Runoff is computed indirectly using the soil type, land cover, and its hydrologic condition, in a model, of course with rainfall data also. The Natural Resources Conservation Service Curve Number (NRCS-CN) formerly known as Soil Conservation Service Curve Number (SCS-CN) method, developed by the USDA-Soil Conservation Service (SCS, 1972), is widely used for the estimation of direct runoff for a given rainfall event from small agricultural watersheds as it takes into account most of the watershed's runoff producing characteristics such as soil type, landuse, hydrologic condition and antecedent moisture condition. The thematic maps corresponding to each parameter may be generated and stored in the common spatial geodatabase created in a GIS with the help of remote sensing data.

Natural Resources Conservation Service Curve Number (NRCS-CN) method is an experimentally derived method to determine rainfall excess using information about soils, vegetative cover, hydrologic condition and antecedent moisture conditions.

The NRCS-CN method is based on a water balance and two fundamental hypotheses which can be expressed, respectively, as follows (SCS, 1972):

$$P = Ia + F + Q \tag{1}$$

where, *P* is the precipitation (mm),  $I_a$  is the initial abstraction (mm), *F* is the cumulative infiltration excluding  $I_a$ , *Q* is the direct runoff (mm).

Let  $I_a$  be the initial quantity of interception, depression storage and infiltration that must be satisfied by any rainfall before runoff can occur. It is based on the hypothesis that ration of runoff (Q) to maximum potential runoff (P-I<sub>a</sub>) and cumulative infiltration (F) to maximum possible infiltration i.e., Retention 'S' is equal, as mentioned below-

$$\frac{Q}{P-Ia} = \frac{F}{S}$$
(2)

 $I_{\text{a}}$  is assumed to be a fraction of S.

$$Ia = \lambda S \tag{3}$$

*S* is the potential maximum retention after beginning of the runoff (mm) and  $\lambda$  is the initial abstraction ratio. Knowing P and S the value of Q can be calculated. Q has the same units of P. On combining (1), (2) and (3), it gives an expression for *Q*:

$$Q = \frac{(P - Ia)^2}{P + S - Ia} \tag{4}$$

Eq. (4) is valid for P > Ia, otherwise, Q = 0. The parameter S in Eq. (4) is defined as

$$S = \frac{25400}{CN} - 254$$
(5)

where, CN is the runoff curve number of hydrologic soil cover, which is a function of soil type, land cover and varies with one of three antecedent soil moisture conditions (AMC): AMC-I, AMC-II and AMC-III. Fig. 1 shows flow chart for NRSC-CN methodology adopting remotes sensing data integrated with GIS.



Fig. 1: Flow Chart Runoff Estimation Using NRCS-CN Integrating RS and GIS

In practice, curve numbers are first calculated for AMC-II and then adjusted to AMC-I or AMC-III depending on the 5-day antecedent rainfall depth that depends on whether the crop is in the dormant or growing season as depicted in Table 1. The values of  $CN_2$  correspond to AMC-II for different landuse against different hydrologic condition of soil group can be found in SCS handbook (SCS, 1972) or standard hydrology textbooks and large number of literature. The values of CN range from 0 to 100. The sample table for  $CN_2$  values corresponds to fallow, row crops, forest, pasture and water body is given in Table 2.  $CN_2$  can be determined by 2 dimensional table or crossing LULC map and hydrological soil group map using cross function of GIS. The LULC map can easily be prepared from satellite data using classification technique based on extensive ground truth. Whereas the detailed soil map can be obtained from the ground truth or made by interpretation of physiographic units and field survey. The National Bureau of Soil Survey & Land Use Planning soil maps are also available with hydrological soil group identified for each soil type for every state.

	5-day antecedent rainfall (cm)				
AMC class	Non-monsoon period	Monsoon period			
I. Optimum soil condition from plastic limit to wilting point	Less than 1.25	Less than 3.5			
II. Average value for annual floods	1.25 to 2.75	3.5 to 5.25			
III. Heavy rainfall or low rainfall and low temperature during five days preceding the storm	Over 2.75	Over 5.25			

Table	1:	AMC	for	Deter	minina	the	Value	of CN
rubic	÷.	/ 10	101	Deter	i i i i i i i i i i g	circ	value	

(Source: - Chow, 1988)

	Table 2:	Curve	Number	Table
--	----------	-------	--------	-------

Land Use/HSG	Α	В	С	D
Fallow	77	86	91	94
Row crops	67	78	85	89
Forest	45	66	77	83
Pasture	49	69	79	84
Water body	100	100	100	100

The daily rainfall data can be procured from any meteorological department, even, spatial rainfall products (like TRMM, CPC, Aphrodite data) of remote sensing data available freely on internet can be utilized. The point data procured from meteorological department can be interpolated using spatial interpolation tools available in GIS. The estimate average weighted rain in each watershed from interpolated rainfall data using zonal statistics tool of Arc GIS. Since the procedure of

estimating weighted average rainfall in all sub-watershed for all rainy days is repetitive work, so a customized model can be build in GIS environment.

Initially, CN<sub>2</sub> for each sub-watershed can be determined based on LULC, soil and hydrologic conditions using traditional NRCS-CN approach adopting corresponding values from Table 1 and Table 2. As, in the original NRCS-CN method the effect of slope has not been taken into account while calculating CN. Moreover, land slope parameter has been considered as an important factor in determining water movement (El-Hassanin et al., 1993; Barros et al., 1999; Ahmad, 2001; Haggard et al., 2002; Chaplot and Bissonnais, 2003; Huang et al., 2006). To overcome the problem of slope, Sharpley and Williams (1990), carried out some slope adjustment to *CN*<sub>2</sub> calculation as follows:

$$CN_{2\alpha} = \frac{1}{3} (CN_3 - CN_2) (1 - 2e^{-13.86\alpha}) + CN_2$$
(6)

Where,  $CN_2$  is slope adjusted  $CN_2$ ;  $\cdot$  (m/m) is the slope. However, this approach has not been intensively verified in the field (Huang *et al.* 2006). Hence, Huang *et al.* (2006) adopted a simplified approach and proposed an equation for slope modified Curve Number ( $CN_2$ .) for slope gradient range from 0.14 to 1.4 as follows:

$$CN_{2\alpha} = CN_2 \frac{322.79 + 15.63(\alpha)}{\alpha + 323.52}$$
(7)

 $CN_2$  and  $CN_3$  in above formulae are the CN for AMC-II and AMC-III respectively. Here alpha is slope in meter per meter. Hope and Schulze (1981) questioned these AMC approach and highlighted three weaknesses in it such as the relationship between AMC and antecedent rainfall holds for discrete classes, rather than continuous; the use of 5-day antecedent rainfall is not based on physical reality, but on subjective judgment; and evapotranspiration and drainage are not considered in depletion of catchment storage. To convert  $CN_2$  to  $CN_1$  &  $CN_3$ ; Sobhani (1975), Hawkins et al. (1985), Chow et al. (1988) and Neitsch et al. (2002); proposed mathematical expressions as presented in Table 3.

Method	AMC – I	AMC - III
Sobhani (1975)	$CN_1 = \frac{CN_2}{2.334 - 0.01334 CN_2}$	$CN_3 = \frac{CN_2}{0.4036 + 0.005964  CN_2}$
Hawkins et al. (1985)	$CN_1 = \frac{CN_2}{2.281 - 0.01281CN_2}$	$CN_3 = \frac{CN_2}{0.427 + 0.00573  CN_2}$
Chow et al. (1988)	$CN_1 = \frac{4.2  CN_2}{10 - 0.058 CN_2}$	$CN_3 = \frac{23 CN_2}{10 - 0.013 CN_2}$

Table 3 CN Conversion Formulae

Neitsch et al. (2002)	$CN_1 = CN_2 - \frac{20(100 - CN_2)}{\{100 - CN_2 + \exp[2.533 - 0.0636(100 - CN_2)]\}}$	$CN_3 = CN_2 \exp\{0.00673(100 - CN_2)\}$
	$(C_{1}, \dots, M_{n}) = (L_{n}, L_{n}) = (L_{n}, \dots, L_{n})$	

(Source:- Mishra *et al.,* 2008)

Mishra et al. (2008) compared these conversion formulae, as determining the CN is very sensitive to runoff calculation. It was suggested that the Sobhani (1975) formula is best for  $CN_1$  conversion whereas the Hawkins et al. (1985) for CN<sub>3</sub> conversion. So, these conversion formulae can be used to calculate  $CN_1$  and  $CN_3$ , respectively for the sub-watersheds falling in such categories.

The representative mean values of  $CN_2$  and  $CN_2$ . for each sub-watersheds can be calculated using zonal attributes tool in Arc GIS. Similarly, the  $CN_1$  &  $CN_3$  for each sub-watershed can be obtained using above conversion formulae along with original NRCS-CN model table. Knowing the values of  $CN_2$  or  $CN_2$ ., and their corresponding  $CN_1$  and  $CN_3$ , the factor S (mm) has been determined for each sub-watershed accordingly. Then  $I_a$  has been estimated using the expression Eq. (3). Usually,  $\lambda$  has been assumed as 0.2 for a large number studies. Finally, the runoff depth in each sub-watershed for each rain event can be calculated adopting the Eq. (4).

### Tutorial

Find out the Hydrological Soil Group (HSG) for each pixel from the given soil map using following table. Open soil map in ArcGIS. You have been provided with DEM, Soil map, LULC map, Rainfall map and watershed boundary map.

Open the given soil map (add layer f\_soil\_text.shp in the ArcMap) in ArcGIS, it will appears somewhat like this:



Now, to see its all soil texture classes, right click on f\_soil\_text.shp layer in Table of content and go to properties, in Symbology tab, select value field, Categories and then select the Soil\_text and click "Add All Values" and then click "ok". We have selected soil texture classes for the display.







Soil	Description of the Hydrologic Soil
Group	group
Α	Lowest runoff potential. Includes deep
	sand with very little clay and silt.
В	Moderately low runoff potential.
	Mostly sandy soil less deeper than A
С	Moderately high runoff potential.
	Comprises shallow soil of clay, colloids
D	Highest runoff potential. Includes mostly
	clay of high swelling percent, nearly
	impermeable soils.

SOIL_TEXT	HSG
Loamy Sand	А
Loamy Skeletal	В
Sand	A
Sandy Loam	Α
Silt Loam	С

Now, open attribute table of soil map, you will find soil type correspond to each polygon for entire watershed.

Q				Untitled - ArcMap			- 6	l X
File Edit View Book	kmarks Insert Selection G	eoprocessing Customiz	e Windows Help			양 네 🔚 퍼   양 🗗   양 🛙	0 -	
Snapping • 🔿 🖽 🗖 J	<b>戸</b> -			📀 f_soil_tex	t 💽 🕸 🐇 🕻	چ 😓 😔 😥 🕹	_	
Editor •   > > > > / 2 2	* 毎・米  四阳車× !	)	🧀 🖬 🕼 🔸 👘 🛍 🛪	: 🔊 (~ 🔿 - 1:114.891	v 🛃 🗔 🥫	👼 🖸 🐎 🛓		
Classification *	: • • • •	] <b>⊘</b>  #⊠ –––––––	🔊 - 🖄   🔥   🕕 🖉 💷	🔛 🗛 🕫 👷 🔟 🗔 🚛	ノとロール人間と		B B B 1002 V E B	ñ 🕒 .
	Georeferencing -		· / X & & & &					
					12日日120			
Table Of Contents	4 ×				- Allowed		×	^
E S Lavers						_		
E 🗹 f_soil_text					Lung			
	ору					$\sim$		
	emove							
Loar	pen Attribute Table				2	$\lambda$		
Loar Joi	Open Attribute Table				T I	✓ <u>\</u>		
Sanc 🖉 2	Open this layer's attribute table	e.						
Silt L	Shortcut: CTRL + double-click					{		
-	se Symbol Levels							
Sel	election	•				E		
la	abel Features	· ·						
Ed	dit Features							
	onvert Labels to Annotation					Y		
San Co	onvert Features to Graphics					5		
Co	onvert Symbology to Representa	ition						
Da	ata	•				8		
🔶 Sar	ave As Layer File		· · · · ·			$\sim$		
🌍 Cri	reate Layer Package				$\sim$			
😁 Pro	roperties					$\sim$		
								>
						-114	73.158 677.603 Meters	
- C 🔒	S 📴 🗉 🥹	o S S	🔍 Q 📐	Same and			🔺 all 👘 🕩 7:	02 AM
								And the second second
Q				Untitled - ArcMap			- 0	×
Q File Edit View Bookr	marks Insert Selection Ge	oprocessing Customize	e Windows Help	Untitled - ArcMap	[▲ @ ] 段 - ] 近	☆ M [[] 田   ☆ g   ☆ g	- 0	×
Q       File     Edit       View     Bookr       Snapping ▼     □	marks Insert Selection Ge	oprocessing Customize	e Windows Help	Untitled - ArcMap	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	☞ <u></u>	- 0 3 <sub>5</sub>	×
Q       File     Edit       View     Bookr       Snapping ▼     □       Editor ▼     ►	marks Insert Selection Ge J -	coprocessing Customize	e Windows Help	Untitled - ArcMap	X -¥ ⊜♪     * 0 • 0	☞ 네 등 대 ☞ 루   야 등 ◇   및   ◇ 500 🚖 -	- 0 ;	×
Q       File     Edit       View     Bookr       Snapping ▼     □       □     □	marks Insert Selection Ge 了。 - 久 - 米   四 山 中 × 雪 - 望 : ● ● ● ◎	coprocessing Customize	: Windows Help ≝ 🖬 🖧 % 🗊 🛍 × ≅ - ♡   k   🗊 🖉 🖉 🗊	Untitled - ArcMap 		☞ 네 HI & ♥   ♥ 8 ◇ I EI ◇ 500 👻 . ● □ I I		×
Q       File     Edit       View     Bookr       Snapping ▼     □       Editor ▼     ►       Classification ▼	marks Insert Selection Ge 了。 "	coprocessing Customize	e Windows Help	Untitled - ArcMap	(<) () () () () () () () () () (	▛┙▙▕▋▌▓▝▖▐₽ ▖▋ৢ▆▋▓▆▋▋▋▋₿		×
Q     File     Edit     View     Bookr       Snapping ▼     ○     田     □     □       E ditor ▼     >     >     ∧     ∧       Classification ▼	marks Insert Selection Ge	coprocessing Customize	e Windows Help	Untitled - ArcMap				×
Q     File     Edit     View     Bookr       Snapping ▼     ○     □     □     □       E     Editor ▼     ト     ト     ↓        Classification ▼	marks Insert Selection Ge	coprocessing Customize	e Windows Help	Untitled - ArcMap 	、 (、 () () () () () () () () () ()	₩₩ <u>₩</u> ₩₩₩₽₩₩₽₽₩₽₽ ●₩ <b>₩</b> ₩₩₩₽₩₩₽₽₩₽ ₩₩₩₩₩₩₩₽₩₩₽₽₩₽₽ ₩₩₽₩₩₽₩₩₽₩₩₽₽₩₽₽	- 0 ; ; @ @ <b>***</b> • 0 @	×
Q     File     Edit     View     Bookr       Snapping ▼     ○     □     □     □       E     Editor ▼     ト     ト     ∠     ∠       Classification ▼   Table Of Contents	marks Insert Selection Ge	soprocessing Customize	: Windows Help : :::::::::::::::::::::::::::::::::::	Untitled - ArcMap : ∳ f_soil_text • • • • 1114.891 	【	₩ M L H Q Q +	- 0 ; ; @ @ <b>***</b> • D @	×
Q       File       Editor       Snapping       Q       Editor       Editor       Classification ×	marks Insert Selection Ge 。 · 41 - 米   公山。中 × ペ 道:Q Q 例 i Georeferencing •   · * ×	soprocessing Customize	: Windows Help 중 등 용 % 한 환 × 왕 - 집 ▶ ● Ø Ø ₪ ♥ / ズ ズ ズ ズ ズ	Untitled - ArcMap : ● f_soil_text • ● ● • 1:114.891 : ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	[《 @ 译····· 	₩₩ <u>₩</u> ₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩	- 0 ; ; @ @ <b></b> ) [] @	×
File     Edit     View     Bookr       Snapping * O     B     C       Editor *       >     A     C       Classification *         Table Of Contents       Stable     S	marks Insert Selection Ge ↓ + ×   ▷ 11 + + × ↑ ↓ • Q Q ¶ ↓ Georeferencing •   ↓ ×	coprocessing Customize	: Windows Help 중 등 음 \	Untitled - ArcMap	(《副译···· (《副译··· (》) (《四译) (》) (《四译) (》) (《四译··· (》) (《四译···· (》) (《四译···· (》) (《四译····· (》) (《四译····· (》) (《四译····· (》) (《四译······ (》) (《四译····································	₩ M & H & K & K & K & K & K & K & K & K & K	- 0	×
Q       File     Edit       View     Book       Snapping * ○ ● □     E       Editor *   ▷ ▷ ▷   ▷     C       Classification *         Table Of Contents       >>     >>       >>     >>       Image: Classification *         Table Of Contents       >>     >>       >>     Classification *	marks Insert Selection Ge ↓ + * +   ▷ 11 + 中 × 5 ↓   ● ● ● ▼ Georeferencing •   ♥ ×	coprocessing Customize	e Windows Help 같이 좋아하는 말을 같은 좋~ ♡   ★   @ / ♡ ♥ / K & & & &	Untitled - ArcMap			- 0	
Q         File       Edit       View       Bookr         Snapping • ○ 田 □       □       □       □         E ditor •   ▷ ▷       ▷       □       □         I classification •       □       □       □         Table Of Contents       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □         □       □       □       □       □	marks Insert Selection Ge	coprocessing Customize	: Windows Help Con Con Yor II (Con Yor II) So Con Yor II (Con Yor II) V / 《 성 성 성	Untitled - ArcMap	【●日平一四日 ● ● ● ● ● ● ■ ■ ■ ■ ■ ■ 「 ○ 平 - 1 ◇ 1 ○ ● 」 ○ 三	● I		
Q         File       Edit       View Bookr         Snapping * ○ ● □ □       □       □         E ditor *   ▷ ▷ ▷   ○       □       □         Classification *       □       □         Table Of Contents       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □         □       □       □       □ <th>marks Insert Selection Ge</th> <th>SAND_PER C_SAND_PER</th> <th>e Windows Help ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ - ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ - ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ - ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■</th> <th>Untitled - ArcMap           Image: Constraint of the state of the state</th> <th>  &lt;</th> <th>Had HSG Maning_n Poros</th> <th>- 0</th> <th></th>	marks Insert Selection Ge	SAND_PER C_SAND_PER	e Windows Help ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ - ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ - ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ - ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	Untitled - ArcMap           Image: Constraint of the state	<	Had HSG Maning_n Poros	- 0	
Q         File       Edit       View       Bookr         Snapping • ○ ● □ □       □       □       □         E ditor •   ▶ ▷ ▷ ▷ ▷       □       □       □         Table Of Contents       □       □       □       □         Table Of Contents       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □       □       □       □       □       □         □       □	marks Insert Selection Ge 	Soprocessing         Customize           Image: Sand_PER         Image: Sand_PER         Image: Sand_PER           32.64         19.1         18.4	Windows Help     Help	Untitled - ArcMap           Image: Constraint of the state	<	Image: Section 1       Image: Section 1 <t< th=""><th>- 0</th><th></th></t<>	- 0	
Q       File       Editor       Snapping       Editor       Editor       Classification ×         Table Of Contents       Image: Classification ×       Image: Classification ×         Table Of Contents       Image: Classification ×         Image: Classification ×	marks Insert Selection Ge ↓ + ★   ▷     + ↓ ★ ↑ ↓ Georeferencing ↓ ↓ ★ ★ ↓ ★ ★ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	SAND_PER C_SAND_PER 3264 129.18 229.28 326.52 326.52 326.54 326.52 327.52 327	Windows       Help         Image: Construction of the state of the st	Untitled - ArcMap           Image: Constraint of the state	Image: Sand Hyd_cond_K       Supervised State         Sand State       Supervised State         Sand State       Supervised State         Supervised State	How	- □ - □ - □ - □ - □ - □ - □ - □	
Q       File       Edit View Book       Snapping * O B □ C       Editor *   ▶ ▷ ▷        Editor *   ▶ ▷ ▷        Classification *         Table Of Contents       Image: Display the options	marks Insert Selection Ge ↓ + ★   ▷ 11 + ⊕ ★ ↑ ↓ ⊕ @ @ @ Georeferencing •   ♥ ★ SILT_PER FINE_SAND_ M. 462 33.62 365 36.64 264 49.26 264 33.57	SAND_PER         CSAND_PER           22.64         19.1           23.64         19.1           24.19         18.6           25.62         18.6	Windows Help     Windows Help     Windows Help     Windows     Windows	Untitled - ArcMap           Image: Constraint of the state	Image: Solution of the second sec	How Solution       How Solution       How Solution         Image: Solution       How Solution       How Solution         Ima	- 0 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	
Q         File       Edit View Book         Snapping * ○ 田 □ □         Editor *   ▷ ▷ ▷   ▷ ▷         Editor *   ▷ ▷ ▷ ▷         Classification *	marks Insert Selection Ge ↓ + *   > 11 + + × 5 ↓ = * +   > 11 + + × 5 ↓ = • × 5 ↓ =	SAND_PER C_SAND_PER 32.64 22.54 19.19 23.55 24.55 25.64 19.19 24.55 25.62 10.15 25.62 10.15 11.1 10.75 25.62 10.15 10.	Windows Help     Windows Help     Windows Help     Windows Help     Windows Help     Windows	Untitled - ArcMap ↓ f_soil_text ↓ 1114,891 ↓ 1114,991 ↓ 1114,	SAND       Hyd_cond_K       Suc         SAND       Hyd_cond_K       Suc         S67       299         83.9       299         83.67       299         76.1       1.09	Hoad       HSG       Maning_n       Porce         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0		
Pile       Edit       View       Books         Snapping * ○       ●       ●       ●         Editor *   ▷       ▷       ▷       ●         Table Of Contents       ●       ●       ●         Table Of Contents       ●       ●       ●         Image:	marks Insert Selection Ge ↓ + *             + ↓ × ↑ Georeferencing •   ♥ × SILT_PER FINE_SAND_ M 4 62 33 92 3 65 36 64 2 64 33 37 4 64 2 2 64 38 37 4 64 2 2 64 66 1 3 7 4 69 30 2 7 4 7 6 9 30 2 7 4 7 6 9 30 2 7 4 7 8 7 7 8 7 8 7 8 7 8 7 8 7 8 7	SAND_PER C_SAND_PER 32.64 19.1 29.1 29.1 20	Windows Help     Windows Help     Windows Help     Windows     F.GRAV_PER     C.GRAV_     V	Untitled - ArcMap ↓ f soil_text ↓ f soil_text	SAND       Hyd_cond_K       Suc_         SAND       Hyd_cond_K       Suc_         SS67       299         84.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         83.6       299         90       200         90       200	H       I		
File Edit View Bookr Snapping C H C Editor + P A C Classification + Table Of Contents Classification + Table Of Contents Classification + Table Of Contents Classification + Table Of Contents Classification + Classification + Classifi	marks Insert Selection Ge ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	SAND_PER C_SAND_PEE 22.64 22.91 24.91 25.92 26.4 25.92 16.6 22.64 19.1 29.19 16.6 22.62 18.6 22.64 19.1 29.19 16.6 17.7 8.26 17.7 18.95 7.77	Windows         Help           Image: Second seco	Untitled - ArcMap           Image: Constraint of the state	Image: SAND       Hyd.cond,K       Suc.         SAND       Hyd.cond,K       Suc.         SS67       299         63.5       299         63.5       299         65.67       299         75.93       299         75.93       299         76.1       1.00         99.95       12.03	Image: High Processing         Image: Processing	- 0 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	
Q         File       Edit View Book         Snapping * ○ 田 □ □         Editor * ▷ ▷ ▷ ▷ ▷ ○         Classification *         Table Of Contents         Image: Classification *         Image: Classific	marks Insert Selection Ge ↓ + ★   ▷   . ↓ ↓ ↓ ↓ Georeferencing ↓ ↓ ★ ★ ★ ↓ SLT_PER FINE_SAND_ M 462 3392 264 49.28 264 49.28 265 49.28 265 49.28 275 49.00 (0 ot of 2 1 + + 1) (0 ot of 2 1 + + + + + + + + + + + + + + + + + + +	SAND_PER         C_SAND_PER           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           22.62         6.3           32.64         19.1           11.1         10.7           8.28         1.7.1           8.29         7.7           82.5         7.7           82.5         7.7	Windows Help     Windows Help     Windows Help     Windows     F_GRAV_PER     C_GRAV_     I     42     7.18     9.26     1     867     1     42     2.16     5     2.16     3     3.17     7     0	Untitled - ArcMap	Image: Solution of the second sec	Hord         HSG         Maning_n         Porce           609         0	- □ □ 	
Q         File       Edit View Book         Snapping * O B I I         Editor * > >          Editor * > >          Table Of Contents         * O B I I         * O B I I         Table Of Contents         * O B I I          O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I         * O B I I      <	marks Insert Selection Ge Georeferencing → Georeferencing → Ge	SAND_PER         C. SAND_PER           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           22.64         19.1           23.64         19.1           11.1         10.7           5.04         2.04           18.59         7.7           55 Selected)         25	Windows Help     Windows Help     Windows Help     Windows     F_GRAV_PER     C_GRAV_     V	Untitled - ArcMap	Image: SAND       Hyd_cond, K       Suc_         SAND       Hyd_cond, K       Suc_         65.67       2.99         60.58       2.99         80.58       2.99         85.67       2.99         75.93       2.99         75.93       2.99         76.1       1.00         96.95       12.03	Image: Solution of the second state	- □ □ 	
Pile     Edit     View     Book       Snapping * ○     ●     □     □       E ditor *     >     >     >       Table Of Contents     ●     ●     ●       Table Of Contents     ●     ●     ●       Image: Image of the state of t	marks Insert Selection Ge Georeferencing → Georeferencing → Ge	SAND_PER C_SAND_PER 32.64 19.1 23.64 19.1 24.59 18.64 24.59 18.64 25.50 17.7 5.04 2.00 18.95 7.77 15.55 19.55	Windows Help     Windows Help     Windows Help     Windows Help     Windows     V     Windows     V     Windows     V	Untitled - ArcMap           Image: Constraint of the system           Image: Consthe system           Image:	Image: Control of the second seco	How         How         Procession           Image: Second s		× • • • • • • • • • • • • • • • • • • •
Q         File       Edit View Book         Snapping * ○ 田 □ □         Editor * ▷ ▷ ▷ ▷ ▷         Classification *             Table Of Contents	marks Insert Selection Ge Georeferencing → Georeferencing → Ge	SAND_PER C_SAND_PER 3.264 [19.1] 2.264 [19.1] 2.264 [19.1] 2.269 [16.3] 2.262 [16.3] 2.264 [19.1] 2.264 [19	Windows Help     Windows Help     Windows Help     Windows     The second	Untitled - ArcMap	SAND       Hyd_cond_K       Suc         SAND       Hyd_cond_K       Suc         S567       299         83.67       209         80.95       12.03	How         How         Procession           Image: Second s		
Q         File       Edit View Book         Snapping * ○ 田 □ □         Editor * ▷ ▷ ▷ ▷ ▷         Editor * ▷ ▷ ▷ ▷ ▷         Classification *             Table Of Contents             Table Of Contents             Image: I	marks Insert Selection Ge Georeferencing - SILT_PER FINE_SAND_ M 462 33.92 365 36.449.24 2.04 38.37 4.62 3.35 9.27 54.09 1.3.87 66.06 1.3.87 4.69 2.25 66.43 2.41 70.23 1. → 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	SAND_PER C_SAND_PER 32.64 [19.1] 23.19 [16.2] 24.2 [19.1] 25.5elected)	Windows     Help       Image: Second s	Untitled - ArcMap	SAND       Hyd_cond_K       Suc_         SAND       Hyd_cond_K       Suc_         S567       299         83.9       299         83.9       299         83.9       299         83.9       299         83.9       299         83.9       299         83.9       299         83.9       299         83.9       299         83.9       299         80.56       100         99.55       1203	H       I	- □ □ 	
File Edit View Book Snapping C B C Editor F F A C Classification F Table Of Contents Classification F Classification F Classificati	marks Insert Selection Ge Georeferencing •	SAND_PER C_SAND_PEE 32.64 19.1 29.19 18.4 29.19 18.4 29.19 18.4 29.29 18.4 29.20 19.1 29.20 19.20 19.1 29.20 19.1 29.20 19.1 29.20 19.1 29.	2     Windows     Help       Image: Second	Untitled - ArcMap	SAND       Hyd_cond_K       Suc_         SSS       299       83         SSS       299       83         SSS       1203       99         895       1203       95         895       1203       90	H       H       I	- 0 0 0 0 0 0 0 0 0 0 0 	
Q         File       Edit View Book         Snapping * O B C       C         Editor *  > >         A         Table Of Contents         Table Of Contents         Image: Classification *         Image: Classification * <tr< th=""><th>marks Insert Selection Ge Georeferencing → Georeferencing → SLT_PER FINE_SAND_ M 462 3392 368 3684 264 4928 264 4928 264 4928 264 4928 264 3837 462 3392 927 4606 1387 6606 225 6643 241 7023 1 → 11 () () () out of 2</th><th>SAND_PER C_SAND_PEE 22.64 19.1 22.91 10.4 22.92 19.6 32.62 19.6 32.62 19.7 32.62 19.7 32.62 19.7 32.62 19.7 32.63 19.7 32.64 19.1 11.1 10.7 32.6 19.7 32.6 19.7 32.7</th><th>Windows Help     Windows Help     Windows Help     Windows     FigRav per C. GRAV     V</th><th>Untitled - ArcMap           Image: Constraint of the second seco</th><th>Image: SAND       Hyd.cond, K       Suc.         Image: Sand Sand Sand Sand Sand Sand Sand Sand</th><th>P = 1       I<th>- 0 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1</th><th></th></th></tr<>	marks Insert Selection Ge Georeferencing → Georeferencing → SLT_PER FINE_SAND_ M 462 3392 368 3684 264 4928 264 4928 264 4928 264 4928 264 3837 462 3392 927 4606 1387 6606 225 6643 241 7023 1 → 11 () () () out of 2	SAND_PER C_SAND_PEE 22.64 19.1 22.91 10.4 22.92 19.6 32.62 19.6 32.62 19.7 32.62 19.7 32.62 19.7 32.62 19.7 32.63 19.7 32.64 19.1 11.1 10.7 32.6 19.7 32.6 19.7 32.7	Windows Help     Windows Help     Windows Help     Windows     FigRav per C. GRAV     V	Untitled - ArcMap           Image: Constraint of the second seco	Image: SAND       Hyd.cond, K       Suc.         Image: Sand Sand Sand Sand Sand Sand Sand Sand	P = 1       I <th>- 0 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1</th> <th></th>	- 0 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	
Q         File       Edit View Book         Snapping * O B I I         Editor *  > >           Editor *  > >           Table Of Contents         No         B         Image: Classification *	marks Insert Selection Ge Georeferencing → Georeferencing → ST_PER FINE SANO_M 462 3392 368 3684 264 4923 264 4924 264 4923 264 4924 264 4924 26	SAND_PER C_SAND_PER 32.64 19.1 22.92 32.64 19.1 11.1 32.64 19.1 11.1 10.7 5.04 20.0 17.7 17.7 15.5 10.0	Windows Help     Windows Help     Windows Help     Windows     To the second sec	Untitled - ArcMap         Image: Constraint of the second secon	Image: Solution of the second sec	Image: Section 1       Image: Section 1       Image: Section 1       Image: Section 1         Image: Section 1       Image: Section 1       Image: Section 1       Image: Section 1       Image: Section 1         Image: Section 1	- □ □ 	
Q         File       Edit View Book         Snapping * ○ 田 □ □         Editor * ▷ ▷ ▷ ▷ ▷ ▷         Editor * ▷ ▷ ▷ ▷ ▷         Classification *             Table Of Contents             Table Of Contents             Image:	marks Insert Selection Ge Georeferencing → Georeferencing → Georeferencing → Georeferencing → Construction	SAND_PER C_SAND_PER 32.64 19.1 23.64 19.1 24.59 18.4 24.59 18.4 25.52 18.6 26.52 18.6 26.52 18.6 26.52 18.6 27.7 5.04 2.00 18.95 7.77 25.52 18.95 7.77	Windows Help     Windows Help     Windows Help     Windows     The second	Untitled - ArcMap	SAND       Hyd_cond_K       Suc.         0.56       2.99         83.8       2.99         83.8       2.99         83.8       2.99         83.9       2.99         83.9       2.99         83.9       2.99         83.9       2.99         83.9       2.99         85.7       2.99         85.7       2.99         86.95       12.03	head       HSC       Maning n       Porce         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         609       0       0       0       0         45       0       0       0       0	Image: state of the state	
File Edit View Bookr Snapping O B C Editor + File C Classification + Table Of Contents Classification + Table Of Contents Classification + Table Of Contents Classification + Table Of Contents Classification + Classification + Classif	marks Insert Selection Ge Georeferencing -	SAND_PER  C_SAND_PER 3264 19.1 29.1 8.4 29.1 8.4 20.1 7.7 20.5 8.4 20.5 8.4 20.	Windows Help     Windows Help     Windows Help     Windows     The second	Untitled - ArcMap	SAND       Hyd_cond_K       Suc         SAND       Hyd_cond_K       Suc         S567       299         83.67       299         83.67       299         83.67       299         83.67       299         83.67       299         83.67       299         83.67       299         83.67       299         83.67       299         83.67       209         96.95       12.03	head     HSC     Maning_n     Porce       600     600     600     600       111     111     111     1111       111     111		

Now we will assign Hydrological Soil Group category based on soil texture class.

A new column will be added in the attribute table of Then go to Table Options and click on "Add Field" give Name as "HSG" and Type as "text". Length you can give "5" as its just single letter (A, B, C, D). Then click "ok".



In given file we have created the HSG column for you.

You will find HSG column has been added to your attribute table. Now, to assign corresponding HSG following steps has to be performed: Go again to Options at the bottom of the window, click "Select by attribute".





Now, double click on Soil\_Text -> click = -> Get Unique Values -> double click "Loamy sand" -> Apply. It will select all polygons of "Loamy sand" class.

Q	_	Unt	itled - ArcMap					-	. 🗇 🛛 🕹
Select by Attributes	Customize Windows H	Help		15	1 昭 - 1 昭 昭 1-1	1 III III III III III IIII IIII IIII I	Nº 15 -		
Cater a WHERE alower to called records in the table window	1		🗞 f soil ted			🖾 😓 500 🗎			
Enter a where clause to select records in the table window.			C						
Method : Create a new selection				* No.					
"SOIL_TEXT"	[ (	0 🦻 🖳 🎬 🕯	n 🦛 💥 🔟 🖻 🕛	18 44 9		희 왜 한 편 변			i 🖾 🏭 🔒
"SAND" "Hyd cand K"	· 之效。	4400	· · · · · · · · · · · · · · · · · · ·						
"Suc_head"					土村送回回	創業日日日	30 .		
"HSG" 🗸									^
				<b>_</b>					
				<u>`</u>					
> >= And									□ × □
< <= Or									
Y () Net									×
				Laundur					^
Is Get Unique Values Go To:	19.11 4.2	2.12	3.66 Loamy Sand	85.67	2.99 6.09	nsc maning_n	0.437	0 105 0 04	
SELECT * FROM f_soil_text WHERE:	18.43 7.18	2.11	6.7 Loamy sand	84.46	2.99 6.09	B 0	0.437	0.105 0.04	
"SOIL_TEXT"	8.38 9.26	5.16	3.69 Loamy Sand	80.58	2.99 6.09	B 0	0.437	0.105 0.04	
	18.61 8.67	4.63	3.46 Loamy Sand	83.9	2.99 6.09	B 0	0.437	0.105 0.04	
	10.74 14.05	0	4 Loamy Sand	75.93	2.99 6.09	B 0	0.437	0.105 0.04	
V	1.76 2.16	1.08	5.19 Sandy Loam	76.1	1.09 10.99	B 0	0.453	0.19 0.08	
Clear Venfy Help Load Save	2.08 3.17	0	2.6 Sand	93.55	12.03 4.9	A 0	0.437	0.062 0.02	
	7.771	· • • •	7.1 I Sand	1 90.95 1	12.031 4.9		0.437 1	0.0621 0.02	>
Apply Close									
Lt soil text									
			1 1			7			
		$\sim$			_	10			
						5			
		~				6			
	· · · ·				~~~~~~	5			
					$\sim$	27			
						$\sim$			
									~
									>
						CARACTER STATE	-3113.631 -4	155.724 Meters	
= 🤗 🔚 🎖 😰 💷 😺 💿	S S 🖬 Q	<u>.</u>	Sala and					🔺 📶 👘 🔶	

Then go to HSG column, right click and then click on Field Calculator and then assign HSG = "B" and click ok. Follow same steps for other soil classes too and assign corresponding HSG group as mentioned table above.

Q	Untitled - ArcMap	- 0 ×
File Edit View Bookmarks Insert Selection Geoprocessing Customize	e Windows Help	<ul> <li>● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●</li></ul>
፤ Editor•  ▶ N/ ノア 草•米  凶臣中× @   ■ 四  🗑 🖕 🛄	Field Calculator	
Classification • Georeferencing • Table Of Contents •	Field Calculator         Parser <ul> <li>VB Script</li> <li>Python</li> <li>Fields:</li> <li>SAND</li> <li>Hyd, cond, K</li> <li>Suc, head</li> <li>HSG</li> <li>Date</li> <li>Fax ()</li> <li>San ()</li> <li>San</li></ul>	★ 1 つ 」 : ● ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○
I4     0     ▶     ▶     II     Image: the second s		
	About calculating fields Clear Load OK	Save
<b>□</b> ▷   ◊ Ⅱ <		2005.229 -4186.123 Metere
E @ E S P E 0 S S		▲ all †0 (0) 7:09 AM



Q	Та	able											_ ×	I
File E	:	· ₽	-   🍢 🍢	3 I 🖓 🤉	¢									L
Snappi	f_;	soil_text											×	
Editor	Г	FID :	hape *	AREA	ID	NAME	SOIL_TEXT	HSG	Maning_n	Porosity	Field_cap	Wp		L
Classif		0 Pc	lygon	3800000	0	Chorasiyawas	Loamy Sand	В	0	0.437	0.105	0.04		L
	L	7 Pc	lygon	4200000	0	hari Bhau Upadhyay Nagar	Sand	A	0	0.437	0.062	0.02		P
	H	8 Pc	lygon	3000000	0	Civil Lines Near NIFD	Sand	A	0	0.437	0.062	0.02	-	L
	H	10 PC	iygon	2800000		Manaveer Colony	Sand	A -	0	0.437	0.062	0.02	-	L
Table (	H	17 Pc	lygon	7200000		Tondara	Sand	Â	0	0.437	0.062	0.02	-	h
Table C	F	19 Pc	lvaon	12000000	ŏ	Beawar Road Near HMT	Sand	A	0	0.437	0.062	0.02		t.
🐮 🖳		22 Pc	lygon	990000	0	Amba	Sand	A	0	0.437	0.062	0.02		H.
🗖 🗐 L		1 Pc	lygon	220000	0	Kayar	Loamy sand	в	0	0.437	0.105	0.04		t.
		2 Pc	lygon	2400000	0	Madar	Loamy Sand	В	0	0.437	0.105	0.04		II.
		3 Pc	lygon	2700000	0	Ratidang	Loamy Sand	В	0	0.437	0.105	0.04		II.
	L	4 Pc	lygon	34662.152	0	Chorasiyawas	Loamy Sand	В	0	0.437	0.105	0.04	_	II.
	H	5 Pc	lygon	7000000		Behind roadways	Loamy Sand	B	0	0.437	0.105	0.04	-	II.
	H	6 PC	iygon	15000000		Valsali Nagar Madar	Sandy Loam	8	0	0.453	0.19	0.08		II.
	H	9 PC	lygon	2300000		Rishi Ghati	Loamy Sand	B	0	0.437	0.105	0.04	-	II.
	F	12 Pc	lygon	12000000	ŏ	Bhag Chand Soni Nagar	Loamy Sand	В	0	0.437	0.105	0.04	-	II.
	F	13 Pc	lygon	7800000	0	Frazer Road	Loamy sand	B	0	0.437	0.105	0.04		L
		15 Pc	lygon	6400000	0	Inderkot	Silt Loam	в	0	0.463	0.232	0.11		L
		16 Pc	lygon	14000000	0	Foy sagar	Loamy Sand	В	0	0.437	0.105	0.04		L
		18 Pc	lygon	13000000	0	Adarsh Nagar	Loamy Sand	В	0	0.437	0.105	0.04		L
	L	20 Pc	lygon	9219.459	0	Foy sagar	Loamy Sand	В	0	0.437	0.105	0.04		L
	H	21 Pc	lygon	9300000	0	Makhupura	Loamy Sand	В	0	0.437	0.105	0.04	-	L
	H	23 Pc	lygon	4500000	177	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13	-	L
	H	24 FU	iyyon	0700000		minops in west side	Loaniy Skeletai		v	0.001	0.204	0.15	-	t.
	H												]	L
-		• •	0	<u> н</u>		/ (0 out of 25 Selected)								h
	2	soil teal	5	PB		🧶 📀 🔮 🚺	3 🖬 Q	<b>.</b>					and[ 👘 📢) 7:16 AM	I

Now we will calculate Curve Number (CN-II) corresponding to land use land cover and HSG Group.

Find out the CN-II for each pixel with the help of HSG derived from soil map and LULC map with the help of table provided below. Open the given LULC map in ArcGIS. Here you have to use spatial Join tool to join attributes of both layers i.e., *f\_soil\_text and lcover05*. ArcGIS ToolBox -> Analysis Tools -> Overlay -> Spatial join.





After joining the two feature layers, a map will be generated with following attributes, now you see soil class and corresponding LULC, so one can derive CN\_II map for the basin.



Q	Tal	ble																×
File E	:=	•   🔁 •   🖣	💦 🖸 🖉 🗙															
Snappi	SO	IL LULC1																×
Editor	П	Join Count	TARGET FID	AREA	PERIMETER	LUSE05	LUSE05 ID	GRID CODE	luse class	NAME	SOIL TEXT	HSG	Maning n	Porosity	Field cap	Wp	HSG SC	_
Classif	H	1	7	529	92	11	10	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		11
. 0.0330		1	8	1058	138	12	11	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		Ē
		1	9	529	92	13	12	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
		1	10	6348	552	14	13	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
_	Ц.	1	11	529	92	15	14	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
ArcToc	H	1	12	529	92	16	15	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
📷 ArcT	H	1	13	529	92	17	16	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
· 🖬 💼 3	H	1	14	1058	138	18	17	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		- 1
	H	1	15	1587	184	19	18	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	B	0	0.501	0.284	0.13		
	H	1	10	42.32	322	20	20	56	Low Mix Venetation	Hill tops in west side	Loamy Skeletal	B	0	0.501	0.284	0.13		
	H	1	18	5819	460	22	20	145	Shruh Land	Hill tons in west side	Loamy Skeletal	B	0	0.501	0.284	0.13		- 1
	H	4	19	220434	56488	23	22	137	Barren Land	Chorasiyawas	Loamy Sand	-	0	0.437	0.105	0.04		- 1
	H	1	20	529	92	24	23	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		- 1
	H	1	21	529	92	25	24	145	Shrub Land	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
	П	1	22	529	92	26	25	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		
		1	23	1058	138	27	26	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		- 1
		1	24	1058	138	28	27	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
		1	25	529	92	29	28	145	Shrub Land	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		- 1
	Ц	1	26	1058	138	30	29	145	Shrub Land	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
🕀 🗎	Ц.	1	28	529	92	32	31	145	Shrub Land	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		- 1
💿 🗎	H	1	29	529	92	33	32	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
🗉 🜍 🤇	H	2	30	2116	230	34	33	145	Shrub Land	Chorasiyawas	Loamy Sand		0	0.437	0.105	0.04		
🗉 📑 🤇	H	1	31	529	92	35	34	109	Exposed Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		- 1
🗉 📦 🕻	H	1	32	529	92	30	35	02	Rocky Terrain	Hill tops in west side	Loamy Skeletal	0	0	0.501	0.204	0.13		- 1
🗉 🌍 E	H	1	33	529	92	37	30	145	Shrub Land	Choraeiyawae	Loamy Sand	0	0	0.301	0.204	0.13		
🗉 🚳 E	H	1	35	529	92	39	38	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		
III 💼 🤅	H	1	36	1058	138	40	39	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		- 1
🖬 💼 c	H	1	37	1587	184	41	40	145	Shrub Land	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		
a 🔬 i	H	1	38	529	92	42	41	145	Shrub Land	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
	П	1	39	529	92	43	42	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		
		1	40	1058	138	44	43	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		- 1
		1	41	1058	138	45	44	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
1 2 2 1		1	42	529	92	46	45	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		- 1
1 🗄 🎇 🧎	H.	1	43	529	92	47	46	137	Barren Land	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		
1 🗄 🌉 🧎	H.	1	44	1058	138	48	47	152	Sandy Soil	Chorasiyawas	Loamy Sand		0	0.437	0.105	0.04		~
🗉 🌌 🧎	<												<u>^</u> '	0.007			>	
	н		0 > >I 📃	🔲   (0 o	ut of 18067 Sele	ected)												
-	٢	11_1131	۵ 👔		0	8	3								<b>an</b>	<b>(</b> )	7:23 AM	

Then go to Options at the bottom of the Attribute of soil map window and click "Add Field" give Name as "CN\_II" and Type as "Short Integer". Precision you can give "0" as they are integer numbers. Then click "ok".

Q					Untitled -	ArcMap					- 0	×
File Edit View Bookmarks Insert	Selection	Geoprocessing Customize Windo	ws Hel	р				Kel	SK =   EC EP  =   []   EI			
						1 A	coil text			500		
Snapping O B B B B				-			_son_text			300		
∃Editor▼ ト M   Z Z 毎~ 帯  □	ih中×	2		9 🖪 🗙	🔊 🖓 🔶	+ 1:115,18	19	🗹 🖾	i 🗊 🚔 🔯 🗁 📮			
Classification •	" : • • · ·	🕅 🥝   💥 😳   🗢 🔶   🕅 - 🖾		9 🖪	🛗 🗛 👘	👷   🐻   🗖	1 1 Z C	4-11 K	台  ち 📑 🖬 🗐 🖉	1 🕄 🖬   🖬 🖬 🔝 🚺	🚾 🗸 🗸 🖌 🖬	£ .
Geo	referencing <b>*</b>		the two	1.11			1					
, 600	referencing	1	+1 +2	-126 -138 -	sen en a se . L					H H L m Ab		
							: 12	기에는	/1종 @1편魚월	日 山   ⑫ 〇 <del>-</del>		
ArcToolbox	ą	× Table Of Contents	×									^
ArcToolbox		A 🜭 🛛 🐟 🛝 🖂							Contraction of the second s			
🗑 🚱 3D Analyst Tools			_									
🖃 🚳 Analysis Tools												
Extract	240	Find and Replace	1 II -						1 HAD BEEN			
🖃 🏷 Overlay			1.11						/ .: ASIA X TREADER & APPART : -	TEN SEP LAOR CORRECTOR		
🔨 Erase		Select By Attributes										
Identity Clear Selection												
Intersect												
Spatial Join	Spatial Join Select All											Lunal
Symmetrical Difference		Add Field	ET_FID	AREA	PERIMETER	LUSE05_	LUSE05_ID	GRID_CODE	luse_class	NAME	SOIL_TEXT	HSG
- Union		Ture All Fields On	1	696534	94622	5	4	82	Rocky Terrain	Chorasiyawas	Loamy Skeletar	-
Drovimity			2	529	92	6	5	109	Exposed Rocky Terrain	Hill tops in west side	Loamy Skeletal	в
Statistics	Ľ	Show Fiel Add Field	3	529	92	7	6	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В
Cartography Tools		Arrange Adds a new field to the ta	ble. 5	529	92	9	8	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В
Conversion Tools		Restore Default Column Widths	6	529	92	10	9	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	B
Data Interoperability Tools		Restore Default Field Order	- /	1058	92	11	10	50	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
🗄 🚳 Data Management Tools		Restore Default field Order	9	529	92	13	12	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
Editing Tools		Joins and Relates	10	6348	552	14	13	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	B
Geocoding Tools		Related Tables +	11	529	92	15	14	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В
🗉 🚳 Geostatistical Analyst Tools	dh	Create Graph	12	529	92	16	15	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В
🗉 🚳 Linear Referencing Tools		A LIT II A L	13	529	92	17	16	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В
🗉 🚳 Multidimension Tools		Add Table to Layout	14	1058	138	18	17	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
🗉 🚳 Network Analyst Tools	2	Reload Cache	16	4232	322	20	10	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	
🗉 🚳 Parcel Fabric Tools	A	Print	17	529	92	21	20	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
B Schematics Tools		Presente a	18	5819	460	22	21	145	Shrub Land	Hill tops in west side	Loamy Skeletal	B
🗉 🚳 Server Tools		Reports •	19	220434	56488	23	22	137	Barren Land	Chorasiyawas	Loamy Sand	
🗄 🚳 Spatial Analyst Tools		Export	20	529	92	24	23	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В
A	_	Appearance	21	529	92	25	24	145	Shrub Land	Hill tops in west side	Loamy Skeletal	B
	-	22 Pelyana - 1	22	529	92	26	25	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	B
		23 Polygon S 3		Q 1058	138	27	20	82	Rocky Terrain	Hill tops in west side	Loany Skeletal	4 AM

Q								Untitled -	ArcMap					- 0	1 ×
File Edit View Bookmarks	Insert Selection	Geopre	ocessing	Customize	Windows	Help					15 @ B	5K - 1 KC 62 million 1			
			-			1			:	and see	-		> con +		
snapping • O to to to g									:   🗸 1	_soll_text			y 500 V V		
Editor •   ► 🗛   Z Z 🖓 • ·	※  豆即車>	21		í 🛓 i 🗋 🐸		* 即	🔒 🗙	S 🖉 🔶	+ 1:115,1	39	- Y 🛃 🗄	I 🗊 🗟 🚳 🖸 🥍 :	-		
Classification •	: • •	5m 🕥	35 50	📥 🔿 🗱	- 🖸   📐		1 🗉	🟥 🗛 者	<b>9</b>   🗔   🖸	1128	1- 11 A	( m s . : 0 0		100% v E 🕅	a .
	. Constanting	_				t at	at at 18								
	; Georeterencing	• []			¥ ¥ ¥	( +13 +	£_+# 8	⊕ ⊞ (· <u>)</u> + [		Ŧ					
										12		/1홍 @]데@\$	1 H H   @ @ -		
ArcToolbox		Ψ× Τ	able Of O	Contents	4×										^
🙀 ArcToolbox		^	- 🛛 😞	🚨 🖂		1				_					
🗉 🜍 3D Analyst Tools				V 1 00				Add	Field	×					
🖃 📦 Analysis Tools											1				
🗉 🏷 Extract						Nam	ie:	CN_II				TROUBLE OF	And and And And		
🖃 🔖 Overlay												1.1.4.1.1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.	- ZER AD LADE LADE		_
🔨 Erase	Та	ble				lype	B:	Short Integer		~					
Identity	(=	- <b></b>	- 🛯 🖌 💦	🛛 🖓 🗙		- Be	Id Prone	tice							
🔨 Intersect	Intersect					su riope	lues								
🔨 Spatial Join	Spatial Join SOIL_LULC1					Precision 0									
Symmetrical Differen	ice	FID	Shape *	Join_Count	TARGET						GRID_CODE	luse_class	NAME	SOIL_TEXT	HSG
🔨 Union	•	0 P	olygon	1							145	Shrub Land	Hill tops in west side	Loamy Skeletal	В
🔨 Update		1 P	olygon	8							82	Rocky Terrain	Chorasiyawas	Loamy Sand	-
🗉 🗞 Proximity		2 M	olygon	1							109	Exposed Rocky Terrain	Hill tops in west side	Loamy Skeletal	- 8
Statistics	H	4 P	nlygon	1							56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
🗄 🜍 Cartography Tools	H	5 P	olvaon	1							82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	в
E Conversion Tools		6 P	olygon	1					ОК	Cancel	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	в
🗉 🜍 Data Interoperability Tools		7 P	olygon	1							82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В
🗄 🚳 Data Management Tools		8 P	olygon	1		Ŀ	020	~~			56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В
🗉 🜍 Editing Tools	H	9 P	olygon	1		10	6348	552	14	13	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	B
B Geocoding Tools		10 P	olygon	1		11	529	92	15	14	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
🗉 🜍 Geostatistical Analyst Tools	H	12 0	olygon			12	529	92	10	15	02	Rocky Terrain	Hill tops in west side	Loamy Skeletal	
🗄 🚳 Linear Referencing Tools	H	13 P	nlynon	1		14	1058	138	18	10	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	8
Multidimension Tools	H	14 P	olygon	1		15	1587	184	19	18	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	8
Image: Analyst Tools		15 P	olygon	1		16	4232	322	20	19	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	В
🗉 🌍 Parcel Fabric Tools		16 P	olygon	1		17	529	92	21	20	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В
B Schematics Tools		17 P	olygon	1		18	5819	460	22	21	145	Shrub Land	Hill tops in west side	Loamy Skeletal	В
🗄 🚳 Server Tools	Ц	18 P	olygon	4		19	220434	56488	23	22	137	Barren Land	Chorasiyawas	Loamy Sand	
🗉 🜍 Spatial Analyst Tools	H	19 P	olygon	1	-	20	529	92	24	23	56	Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B
<u> </u>	H	20 P	olygon	1		21	529	92	25	24	145	Shrub Land Rocky Terrain	Hill tops in west side	Loamy Skeletal	8
		21 P				22	1058	92	20	25	82	Rocky Terrain	Hill tons in west side	Loany Skeletal	B
	2	23	olygon	8	M		1058	138	28	27	82	Rocky Terrain	Hill tops in west side	Loamy Skeletal	25 AM

You will find CN-II column has been added to your attribute table. Now, to assign corresponding CN\_II values from table in this column. Go again to Options at the top of the window, click "Select by attribute". Now, double click on "luse\_class" -> = -> Get Unique Values -> 'Barren Land' -> AND -> double click "HSG" -> = 'A' -> Apply. It will select all polygons with "agriculture" LULC class and "A" HSG class.

Q	Untitled - ArcMap – 🗇 🗙											
Select by Attributes	Customize Windows H	Help		P	A 🕤 🕅	-   KI KP 1-		3 9/1	R <sup>0</sup> Eg .			
Enter a WHERE clause to select records in the table window.											n ×	
Method : Create a new selection												
"SOIL TEXT"											×	
"SAND"	E luse class	NAME	SOIL TEXT	HSG	Maning n	Porosity	Field cap	Wp	HSG SOIL		^	
"Hyd_cond_K"	15 Shrub Land	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		0		
"Suc_head"	32 Rocky Terrain	Chorasiyawas	Loamy Sand		0	0.437	0.105	0.04		0		
"HSG" v	9 Exposed Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		0		^
	32 Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		0		
= <> Like	6 Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		0		
	32 Rocky Terrain	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		0		
B.	6 Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		0		
< <= Or	32 Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		0		
	6 Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	в	0	0.501	0.284	0.13		0		
_ % () Not	32 Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		0		
	56 Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		0		
Get Unique Values Go To:	32 Rocky Terrain	Hill tops in west side	Loamy Skeletal	В	0	0.501	0.284	0.13		0		
SELECT * FROM SOIL_LULC1 WHERE:	56 Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	B	0	0.501	0.284	0.13		0		
"luse_class" = 'Fallow Land' AND "HSG" = 'B'	p6 Low Mix Vegetation	Hill tops in west side	Loamy Skeletal	8	0	0.501	0.284	0.13		0		
	sz Rocky Terrain	Hill tops in west side	Loamy Skeletal	8	0	0.501	0.284	0.13		0		
	2 Rocky Terrain	Hill tops in west side	Loamy Skeletal		0	0.501	0.284	0.13		0		
	5 Charle Land	Hill tops in west side	Loamy Skeletal		0	0.501	0.204	0.13		0		
· · · · · · · · · · · · · · · · · · ·	37 Barran Land	Choraekrawae	Loamy Skeletal	•	0	0.501	0.204	0.13		0		
Class Visits Usis Lord Cour	6 Low Mix Vegetation	Hill tone in west side	Loamy Skeletal	B	0	0.437	0.103	0.04		0		
Clear Venity Help Load Save	15 Shrub Land	Hill tone in west side	Loamy Skeletal	H.	0	0.501	0.284	0.13		0	~	
Apply Close										2	>	
									-			
Geocoding Tools		( B	Tole State	1	1 T	21. <b>94</b>						
🗉 😋 Geostatistical Analyst Tools				f	1.0	1 <b>1</b> - <b>1</b>	15 . 14	10 yiz	12 1			
🗉 🜍 Linear Referencing Tools		S. C. S.	- Aller			$C \sim N_{\odot}$	1 . A. S.	325		SP		
🗉 🚳 Multidimension Tools		are - my	<i>v</i>			The second	1. 1.	ef		5		
🗉 🜍 Network Analyst Tools					9	15			1.00			
Parcel Fabric Tools					1	100	4		and the second	1.077		
Schematics Tools						-		-	5	131		
Server Tools									1			
Spatial Analyst Tools												×
		⊠ 0   ∂ II <										>
									15931.857 6	6234.352 M	leters	
i (e 📻 S 😢 🗉 🔮 🧕	🖷 🤗 😭 🖽 🕑 🧿 🕿 S 📵 😕 🔍											

Then go to CN-II column -> right click -> Field Calculator -> CN-II = "49" -> ok.

Q	Q Untitled - ArcMap – 🗗 🗙																	
File Ed	lit View	Bookmarks	Insert	Selection Ge	oprocessing	Customize Windows	Help				S 💼 🖾	「気気をす		3 🗐 /	R <sup>0</sup> Eg .			
																	□ ×	
🔁 v   🖳	<b>N</b>	🗛 🗙 i 🕅 i	n di x															
	<u>.</u>	4 - m - Ll -															×	
RGET FID	ADEA	DEDIMETED	L II SEOS	LUSE05 ID	GRID CODE	luca clace	NAN	1E	SOIL TEXT	HSG	Maning n	Porosity	Field can	Wo	HSG SOIL	CN II	-	<b></b>
689	529	92	693	692	102	Fallow Land	Madar	n	Loamy Sand	B	0	0.437	0.105	0.04	1130_3012	65		
708	529	92	712	711	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0.105	0.04		65		
743	1058	138	747	746	102	Fallow Land	Madar		Loamy Sand	В	0	0.437	0.105	0.04		65		^
850	529	92	854	853	102	Fallow Land	Madar		Loamy Sand	В	0	0.437	0.105	0.04		65		
1030	1058	138	1034	1033	102	Fallow Land	Madar		Loamy Sand	8	0	0.437	0.105	0.04		65		
1197	529	92	1201	1200	102	Fallow Land	Madar		Loamy Sand	B	0	0.437	0.105	0.04		65		
1198	529	92	1202	1201	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0.105	0.04		65		
1537	1587	184	1541	1540	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0.105	0.04		65		
2749	1058	138	2753	2752	102	Fallow Land	Madar		Loamy Sand	В	0	0.437	0.105	0.04		65		
2819	1587	184	2823	2822	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0.105	0.04		65		
2852	529	92	2856	2855	102	Fallow Land	Madar		Loamy Sand	В	0	0.437	0.105	0.04		65		
2855	529	92	2859	2858	102	Fallow Land	Madar		Loamy Sand	В	0	0.437	0.105	0.04		65		
2880	1587	184	2884	2883	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0.105	0.04		65		
2001	1056	130	2005	2004	102	Fallow Land	Madar		Loamy Sand	D	0	0.437	0.105	0.04		65		
2912	4761	322	2910	2915	102	Fallow Land	Madar		Loamy Sand	B	0	0.437	0.105	0.04		65		
3012	1058	138	3016	3015	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0,105	0.04		65		
3046	529	92	3050	3049	102	Fallow Land	Madar		Loamy Sand	в	0	0.437	0.105	0.04		65		
3128	1058	138	3132	3131	102	Fallow Land	Madar		Loamy Sand	В	0	0.437	0.105	0.04		65		
3160	1587	184	3164	2162	102	Fellow Lend	Madar		Loamy Sand	R	٥	0 /37	0 105	0.04		65	, ×	
																	>	
manage or a			out of 180	o/ Selected)														
JLC1		Sho	w selected	records												_		
🕀 🜍 G	ecoding	Tools						and the second	The state	/ *	A CARLEND	21. H	- <u>- 1</u>					
🗉 🌍 G	ostatistic	al Analyst Too	ls					AB. Pr			larger !!	242 B	1 - A - A - A - A - A - A - A - A - A -	چاہر کہ	10 m			
🗉 🌍 Li	near Refer	encing Tools						A DEMAN	a constant			$C < S_{c}$	1 . A. A.	5.57		SP-		
🗉 🚳 M	ultidimen	sion Tools							<i>v</i>		100	the second	ALC: CAL	e e		-5		
🕀 😂 N	twork An	alyst Tools									2	100						
🛞 🚳 Pa	rcel Fabri	c Tools									1	100	4		C THE	1		
🖽 🚳 So	hematics	Tools													7	121		
🕀 🚳 Se	rver Tools																	
🗉 🌍 Sp	atial Anal	yst Tools																×
-															15078.495 -	2573,5651	Meters	
-																		

Follow same steps for other combinations too such as

LULC_CLASS	А	В	С	D
Barren Land'	49	69	79	84
Dense Mix Vegetation	26	40	58	61
Exposed Rocky Terrain	77	86	90	93
Fallow Land	39	61	74	80
Low Mix Vegetation	28	44	60	64
Rocky Terrain	77	86	90	93
Sandy Soil	25	44	55	60
Settlement	89	92	94	95
Shrub Land	49	68	79	84
Water	100	100	100	100
Wet Alluvium Soil	91	95	96	98

"Barren Land" lulc class and "A" HSG, CN\_II "49";

"Dense Mix Vegetation" lulc class and "A" HSG, CN\_II "26";

"Exposed Rocky Terrain" lulc class and "B" HSG, CN\_II "86";

Now we will use the raster calculator for further calculations.

Now, to prepare CN-II map by converting polygon map into raster map, go to ArcToolbox -> Conversion Tools -> To Raster -> Polygon to Raster



Input Feature will your spatially joined soil and LULC map, Value Field will be CN\_II column, Output Raster Dataset will be your CN\_II\_Map. Make Sure the cell size should be same as DEM cell size, as we have to all analysis at DEM cell size.



Then carry out slope correction in CN-II using Huang (2006) approach. Derive slope map from provided ASTER DEM using Spatial Analyst Tool.

#### Go to ArcGIS Toolbox -> Spatial Analyst Tools -> Surface -> Slope Input Rater will be dem, Output Raster will be Slope and Output Measurements



(optional) will be PERCENT\_RISE, then click "ok".

To convert slope percentage map in *slope meter per meter*, the slope percentage map should be divided by 100. For this operation use raster calculator. Using following equation.

Go to Spatial Analyst Tools -> Map Algebra -> Raster Calculator



Slope\_mpm = "Slope\_per" / 100



The original NRCS method has been developed for slope less than 5% but in your case slope may vary more than 5%. So to incorporate slope in calculation Huang (2006) proposed following equation for NRCS method:

Huang (2006)  

$$CN_{2\alpha} = CN_2 \frac{322.79 + 15.63(\alpha)}{\alpha + 323.52}$$

Same equation has been used in raster calculator for slope correction.

## "CN\_II\_Map" \*((322.79 + (15.63 \* "Slope\_mpm")) / ("Slope\_mpm" + 323.52))

Give output names as "CN\_II\_slp"



Keep a check, the value of CN-II slope corrected should not exceed 100. If it is exceeding 100, then open Raster Calculator again and put following

Con("CN\_II\_slp" > 100,100,"CN\_II\_slp")

#### Give output names as "CN\_2"

Further, as discussed above, depending upon the AMC condition (Antecedent Moisture Condition) which is to be calculated based on last five days precipitation, CN2 needs to be converted into CN\_1 or CN\_III

To convert CN2 TO CN1 according to AMC condition use following condition in raster calculator.

"CN\_2" / (2.334 - 0.01334 \* "CN\_2")

#### Give output names as "CN\_I"



To convert CN2 TO CN3 Acc. To AMC condition

"CN\_2" / (0.427 + 0.00573 \* "CN\_2")

#### Give output names as "CN\_III"



To find out actual CN according to AMC, first of all add 5 raster data having preceding 05 days precipitation. Click on Add data then go to data folder where your 05 days rainfall data set is available (*rainfall*). Select rainfall and click ok. Then to calculate Curve number

as per the AMC condition use raster calculator and put following condition in Raster calculator

Con("rainfall" <= 35,"CN\_I",(Con("rainfall" >= 52.5,"CN\_III","CN\_2")))

#### Give output names as "CN\_actual

Please refer NRSC method of runoff estimation, now we need to calculate Maximum Potential Retention "S". Again go to spatial analyst in ArcTool Box and click on map algebra and then Raster calculator. Then use the mathematic expression to compute S.

 $S = (25400 / "CN_actual") - 254$ 

#### Give output names as "S\_MAP"



To calculate initial abstraction "I", again go to Raster calculator and use following expression (condition) to calculate initial abstraction.

I=0.2 \* "S\_MAP"

#### Give output names as "I\_MAP"



#### To calculate runoff depth "Q"

Q will be estimated only when rainfall P > I that means whenever Initial abstraction is less than rainfall, then only runoff will occur. We will use event rainfall which is available as rainfall\_aoi (one day rainfall) to calculate runoff.

Con("rainfall\_aoi" >= "I\_MAP", Power(("rainfall\_aoi" -"I\_MAP"),2) / ("rainfall\_aoi" + "S\_MAP" - "I\_MAP"),0)

#### Give output names as "Q\_MAP"



**To Calculate runoff coefficient** –Runoff coefficient is a ration of runoff and rainfall for a particular area. If we have runoff coefficient for any watershed then we can calculate runoff for any given rainfall event. Please go to again raster calculator use following expression to estimate runoff coefficient for above discussed watershed.

"Q\_MAP" / "rainfall\_aoi"

Give output name as runoff\_coe and click ok.



Further exercise to calculate runoff will be done in excel

- 1. You have been given daily rainfall of ajmer , identify dormant and growing season (1 june to 31 October has been consider as a growing season)
- 2. Calculate

Q	Untitled - ArcMap	- 0 ×
File Edit View Bookmarks Insert Selection Geo	processing Customize Windows Help 🔨 🍙 🖾 - 🛙 🖾 😰 🗐 🕍 🖾 🕼 🖳 🖗 🖳	🖕 🐼 soil 💽 💽 🐨 💭 🐨 🜉
i Snapping - 🔿 🖽 🗖 🚅 🗖 💭 👘	🛍 🗙 🔊 (*) 🛧 📲 [1:150,000 🛛 🗸 🙀 🔜 🔽 🧊 🚽 🖓 🚽	- 才 ※ ◎ 回 ゐ 絮 目 田 ◎ ◎ -
Editor・トトレファ 年間国由中×9		
i 🔍 Q. 🖑 🎱 i XX 23 i 🗢 🔿 i 🕅 - 🖾 i 💽 👔	K IDW	
Classification - Slope_per 💽 📰 🐙	Ion it point fash rec	Output cell size (optional)
Table Of Contents # ×		
%: 📮 🐟 🐥 🖽	Z value field	The cell size at which the output raster will be created.
🖃 🥰 Layers 🔷	avg_rainfa v	This will be the value in the environment if it is explicitly set: etherwise, it
🖃 🚞 G:\Ajm	Output raster	is the shorter of the width or the height of the extent of the input point
	G:\Ajm\ajmer\tutorial\New File Geodatabase (2).gdb\Rainfall_Map_n	features, in the input spatial reference, divided by 250.
•	Output cell size (optional)	
	30 🖻	
	Power (optional)	
	2	
🗉 🧮 G:\Aim\aimer\tutorial	Search radius (optional)	
Export_Output	Variable V	
	Search Radius Settings	
LULC_Soil	Number of points: 12	
	Maximum distance:	
Gl Aim aimer tutoria		
	Input barrier polyline features (optional)	
□ ☑ Sub_Watershed		
🖃 🛅 G:\Ajm\ajmer\tutorial\		
CN_2_SIp		
Value		
High: 100.555		
Low : 24.9436		×
	OK Cancel Environments << Hide Help	Tool Help
	on concertaintener KKritteriep	
		-6981.015 6966.359 Meters
# 🧉 😹 S 😰 🖩 ⊌	3 S S Q # 👗 XI S	🔺 and 📆 🕼 6:01 PM