Green Roads for Water Training in Sudan

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Erosion Protection and Water Guiding Techniques

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Soil

The soil is the top layer of the earth's surface. It is made up of dirt and rock. It is filled with air and life.

Soil Erosion

- It is a process in which the top (fertile) layer of soil is lost.
- The top layer of soil is very light which is easily carried away by wind and water.
- The removal of topsoil by the natural forces is known as soil erosion.

Causes of Soil Erosion

Various agents, strong winds blow, water flow, deforestation, overgrazing by animals, etc., cause soil erosion.

Types of Erosion (transport)

1. Erosion by the wind

Prevalent in locations where natural vegetation is scarce. After becoming loose, the soil particles are blown and transported away by the wind.

2.Erosion caused by water

Water erosion can be caused by raindrops, waves, or ice. The severity and kind of soil erosion caused by water are classified differently.

Based on the nature and extent/form of soil removal, wash erosion is classified as:

1. Sheet erosion
2. Rill erosion (shallow channels)
3. Gully erosion (deep channels)
4. Stream bank erosion
5. Land slumping / collapsing, piping, tunnelling

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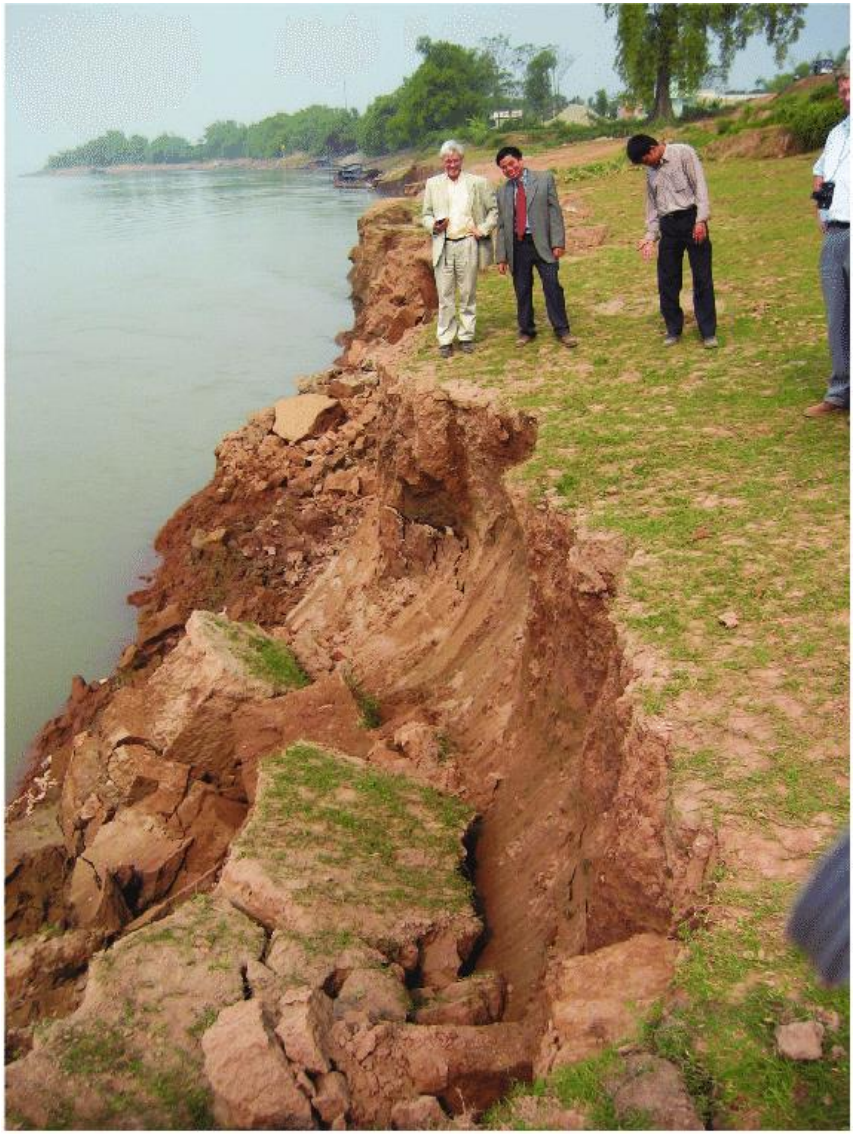
Land slide



Soil Conservation is the prevention of soil erosion

Types of water erosion control:

- Erosion is generated by the impact of **rainfall** and the **flow of water** run-off.
- Intervention must encourage one of the following objectives:

✓ Increasing stability and resistance of aggregates;
✓ Absorbing rain energy;
✓ Limiting or slowing down surface run-off;
✓ Reducing surface run-off by boosting infiltration.

Stone bunds (embankment) along unpaved road to reduce erosion

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Contour bunding :

These are rows or barriers of stone blocks (approx. 25 cm in diameter) perpendicular to the direction of water flow.

Terraces :

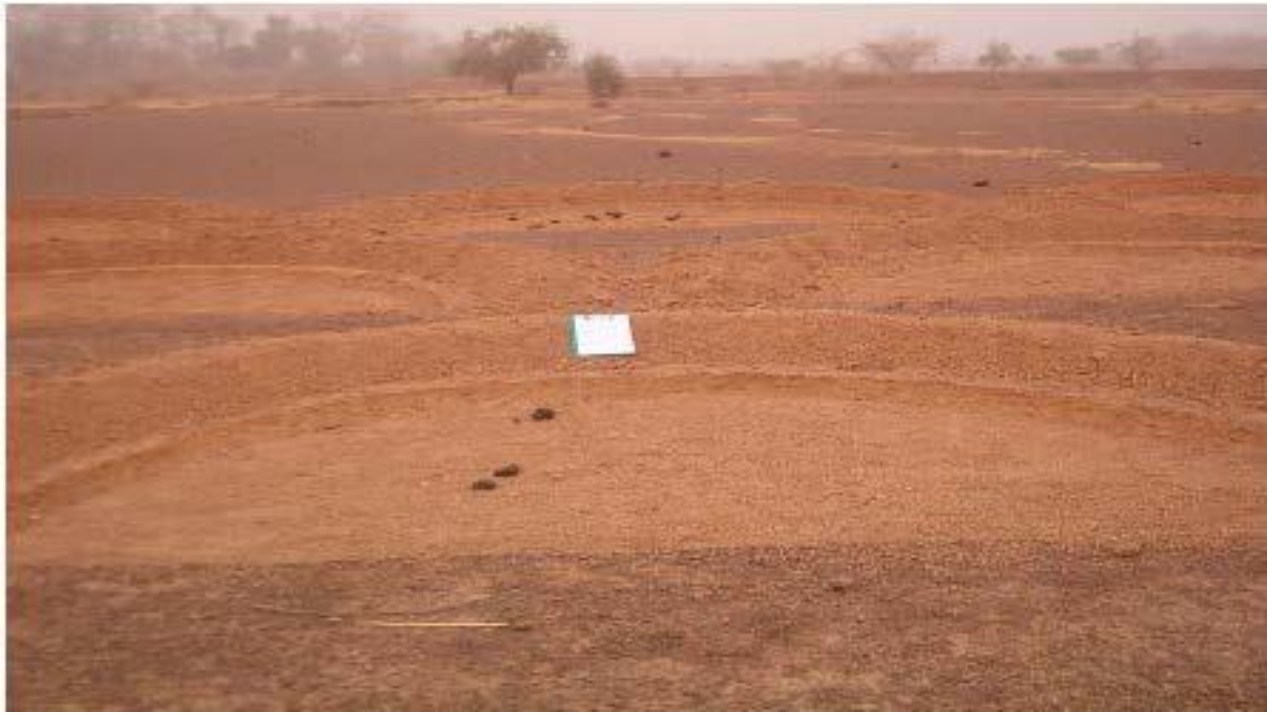
- Used in mountainous landscapes.
- Progressive terraces (contour bunds) are used to slow down the surface run-off and retain the land on top of the slopes,
- Step terraces are used control soil erosion & store water in semi-arid environments

Mulching

Covering the soil with a layer of grass or dry straw that is 2 cm thick.

Half-moon Terraces

Basin created in the form of an open semi-circle with the aid of a pick, axe and shovel. The excavated dirt is deposited around the semi-circle to create a raised semi-circle with a flattened top (4 m in dia. 0.15 to 0.25 m depth)



Different Ploughing Techniques

The different types of ploughing (disc ploughing; moldboard ploughing; or mounted ploughing).

Brushwood revetment
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Riprap revetment

- Rocky material placed along slopes, bridge foundations, to protect from scour and erosion.
- Rock size depends on the steepness of the slope and how fast water is movi
- Riprap is a very durable, natural-looking treatment.
- Not be easily traversable by animals; filling the open spaces between the rocks with soil or smaller rocks helps to address this issue.

Rock pitching

Mortar Rock Pitching

Dry Rock Pitching

Gully created as a result of flow through culverts

Gully control practices

Loose stone checkdam with apron and parabolic spillway

Planting reshaped gully with elephant grass

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Loose stone in trenches

Loose stone checkdam covered with bamboo mat

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Gabion checkdam

Brushwood checkdam

Water diversion:

Water diversion includes the construction of side drains, levees, pumping stations, canals, weirs, or any other manmade structure that modifies the natural flow of a waterway.

Swales are shallow broad and vegetated channels designed to store and/or convey runoff and remove pollutants

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Dry Stream/ dry creek bed is a landscape feature that simulates a creek or stream bed using rocks

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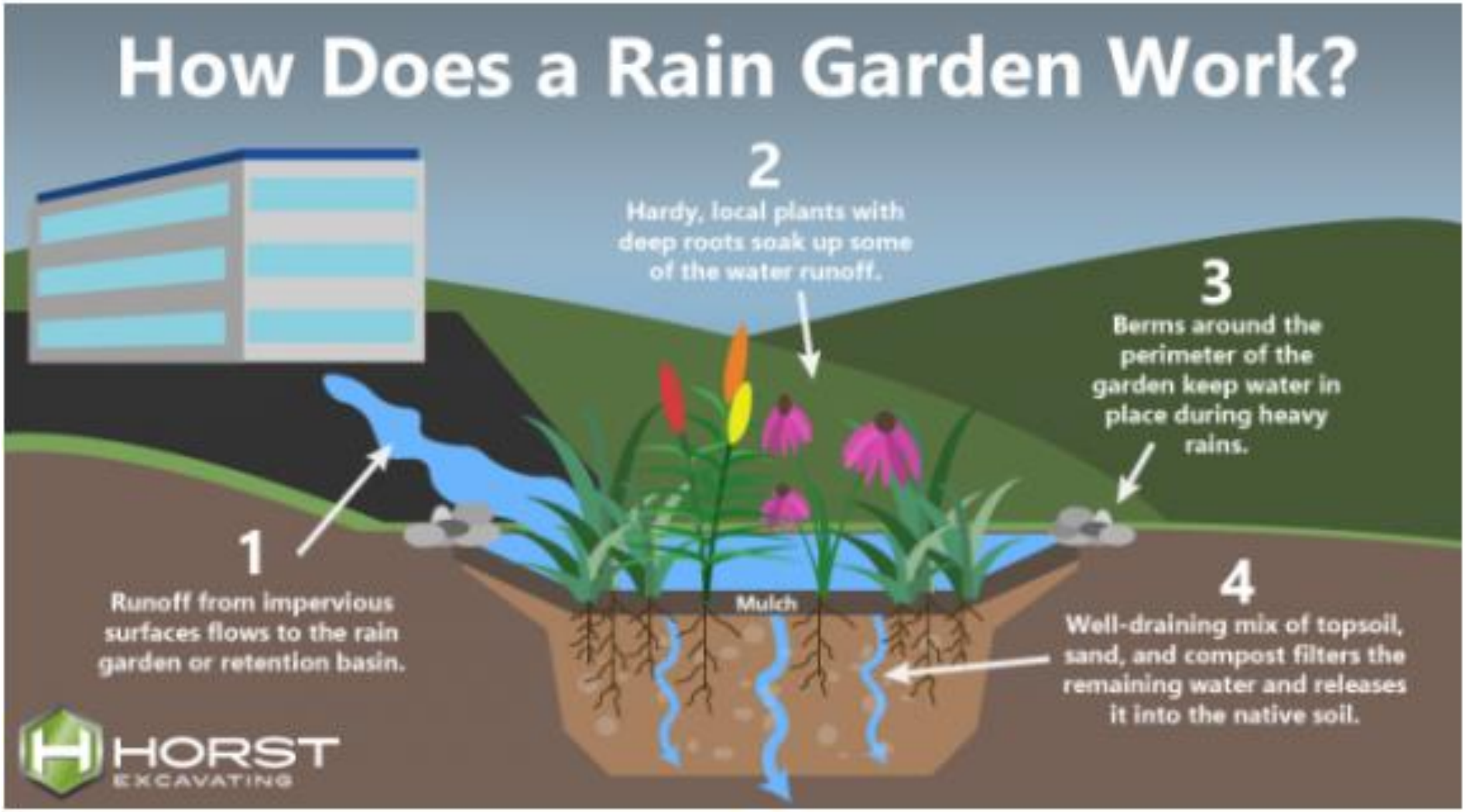
Rain Garden:

- A basin that is designed to capture and infiltrate stormwater runoff.
- A shallow depression is lined with an easy-draining soil mixture of topsoil, sand, and animal dung.
- Hardy native plants are then planted in this basin.
- Stormwater runoff collects in the garden, is filtered through the soil, and is slowly released back into the ground.
- Berms surround the perimeter of the basin to keep the rainwater in the designated area.



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Road side runoff diverted into ponds for surface water storage and groundwater recharge.

Water from a culvert is channeled into farmlands

Road side runoff is channeled into farmlands 1.improve soil moisture 2.reduce runoff to downstream areas 3. reduce erosion

Road side drainage

Diversion of culvert water into a borrow pit

Diversion of culvert water into an old rock quarry

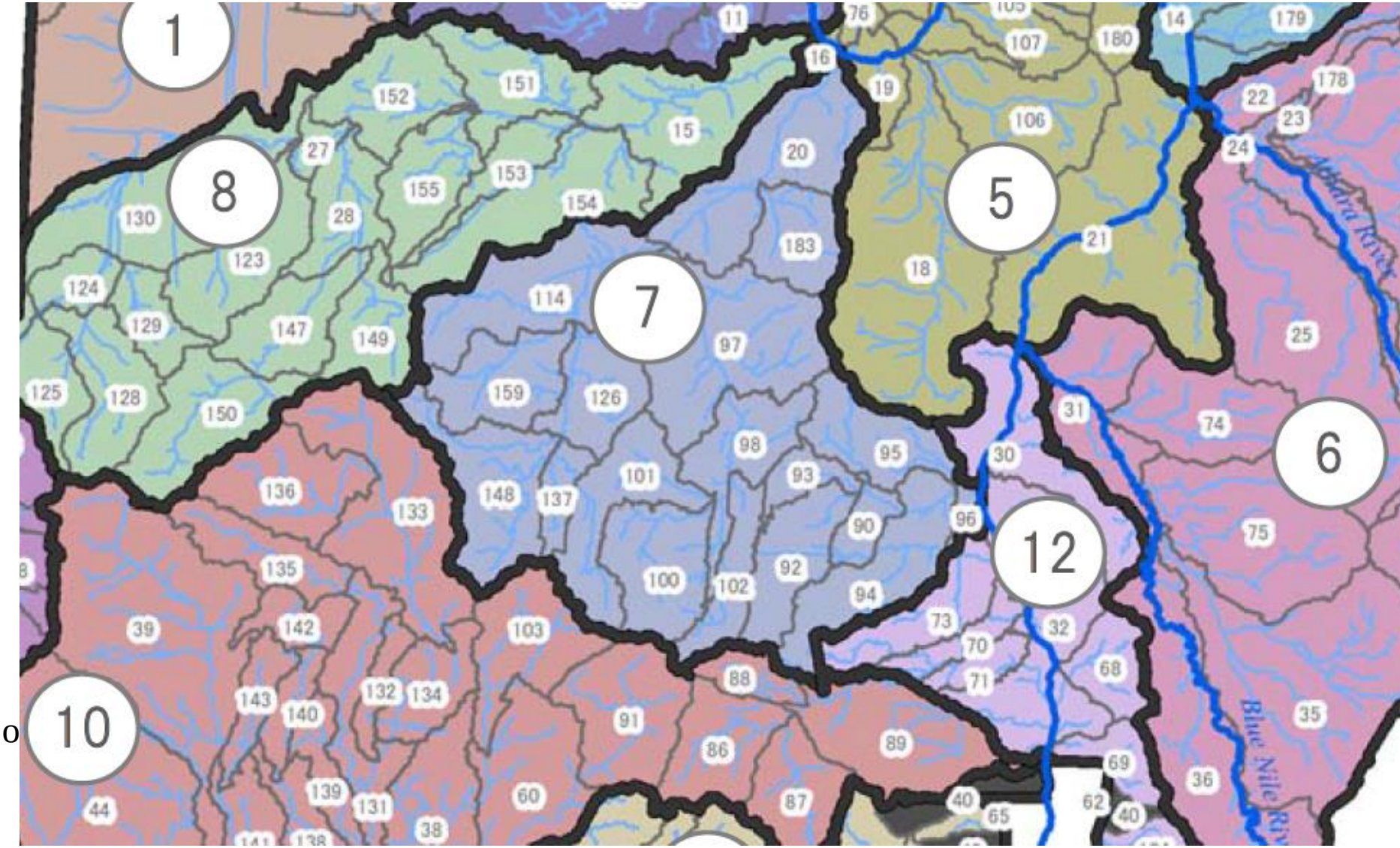

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Table 4-13 Calculation Result of Water Resources Potential of Surface Water

Sub-basin No.	Clay %	Silt %	Sand %	Catchment Area (km^2)	34-year Average Annual rainfall (mm)	Average annual discharge (MCM)**	Discharge(MCM) / Area ($1,000,000m^2$) *1,000 (mm)	Runoff ratio d / b	Parameter applied from
0	20	7	73	10,258.48	10.6	0.07	0.01	0.001	Sand
1	20	2	78	529.72	-	-	-	-	-
2	39	14	46	41,599.58	49.4	13.89	0.33	0.007	177
3	22	6	68	30,415.17	7.1	0.89	0.03	0.004	Sand
4	21	2	77	31,706.26	7.1	1.08	0.03	0.005	Sand
5	-	-	-	-	-	-	-	-	-
6	29	18	52	38,731.77	9.1	1.45	0.04	0.004	118
7	43	16	41	14,648.12	22.6	1.35	0.09	0.004	177
8	20	3	77	80,783.66	67.9	14.93	0.18	0.003	Sand
9	31	15	53	16,824.36	12.8	0.67	0.04	0.003	177
10	30	19	50	15,860.05	11.3	0.49	0.03	0.003	177
11	23	18	59	8,842.91	11.0	0.20	0.02	0.002	177
12	30	31	40	4,143.82	23.9	0.34	0.08	0.003	177
13	48	17	36	6,317.68	114.0	3.81	0.60	0.005	187
14	27	27	45	11,848.05	38.5	0.64	0.05	0.001	177
15	20	3	77	16,748.51	11.6	0.88	0.05	0.005	Sand
16	21	25	52	1,193.34	12.5	0.02	0.02	0.001	SCL+Sand
17	20	5	75	245.28	121.7	-	-	-	Sand
18	32	16	51	35,869.77	71.9	14.82	0.41	0.006	SandClay
19	26	15	58	4,152.26	14.3	0.35	0.08	0.006	SCL+Sand
20	28	8	63	16,830.98	44.3	3.30	0.20	0.004	SCL+Sand
21	37	23	39	35,560.29	66.6	12.68	0.36	0.005	74
22	37	21	42	8,792.81	44.9	2.53	0.29	0.006	177
23	35	22	43	1,715.52	46.8	0.10	0.06	0.001	177
24	39	26	35	11.46	-	-	-	-	-
25	43	27	30	33,545.45	207.3	24.10	0.72	0.003	74
26	41	26	32	7,091.54	237.3	9.87	1.39	0.006	74
27	22	5	73	1,832.13	127.1	1.18	0.64	0.005	Sand
28	20	3	77	6,967.18	131.9	2.53	0.36	0.003	Sand
29	-	-	-	-	-	-	-	-	-
30	40	25	32	14,422.21	189.5	8.10	0.56	0.003	74

Sub-basin No.	Clay %	Silt %	Sand %	Catchment Area (km^2)	34-year Average Annual rainfall (mm)	Average annual discharge (MCM)**	Discharge(MCM) / Area ($1,000,000m^2$) *1,000 (mm)	Runoff ratio d / b	Parameter applied from
100	20	4	75	10,356.43	289.5	18.03	1.74	0.006	Sand
101	25	14	61	10,846.89	283.1	28.22	2.60	0.009	88
102	21	6	73	5,778.78	298.3	20.30	3.51	0.012	Sand
103	22	6	71	11,104.77	354.2	13.22	1.19	0.003	60
104	43	19	38	3,287.44	16.1	0.22	0.07	0.004	177
105	33	12	54	2,311.55	18.9	0.09	0.04	0.002	177
106	34	16	50	14,479.58	38.4	2.04	0.14	0.004	177
107	43	19	38	4,984.80	18.8	0.41	0.08	0.004	177
108	20	6	74	7,752.72	9.8	0.21	0.03	0.003	Sand
109	20	3	78	3,286.41	10.3	0.05	0.01	0.001	Sand
110	21	5	74	4,744.17	13.4	0.18	0.04	0.003	Sand
111	28	14	58	5,762.19	11.2	0.19	0.03	0.003	118
112	21	34	45	3,508.00	11.8	0.08	0.02	0.002	118
113	28	27	45	5,180.67	11.8	0.22	0.04	0.004	118
114	22	3	75	16,749.19	322.0	32.75	1.96	0.006	Sand
115	20	35	45	5,933.78	286.0	22.76	3.84	0.013	118
116	22	34	44	8,666.87	334.7	38.56	4.45	0.013	118
117	23	29	48	4,484.18	285.5	29.59	6.60	0.023	-
118	21	34	45	4,228.02	396.4	41.29	9.77	0.025	-
119	46	20	34	3,628.55	396.4	23.32	6.43	0.016	118
120	35	25	39	8,821.76	408.2	51.53	5.84	0.014	118
121	-	-	-	-	-	-	-	-	-
122	44	29	27	4,723.83	150.0	6.22	1.32	0.009	118
123	21	8	72	11,599.15	158.1	10.01	0.86	0.005	Sand
124	23	7	70	3,651.31	158.1	5.54	1.52	0.010	Sand
125	34	11	55	6,294.06	255.8	9.02	1.43	0.006	118
126	26	12	62	7,731.30	255.8	16.37	2.12	0.008	88
127	25	13	62	10,040.89	165.6	15.13	1.51	0.009	118
128	22	11	68	9,815.35	165.6	9.55	0.97	0.006	Sand
129	22	8	71	4,621.73	157.8	3.77	0.81	0.005	Sand
130	21	3	76	19,577.53	57.6	9.25	0.47	0.008	Sand

Thank you!