

## सारांश / ABSTRACT

- 1. Survey Area** : "5D2D3g1 to g5, D4a1 to a4, D4b1 to b4, D4c1 to c3, D4h1 to h9, D4j1 to j8, D4k1 to k3, D4m1, D5j1 to j2 and D6h1 to h2" micro watersheds of Narmada Catchment (5D2),RVP, Taluka-Khategaon, Dist.- Dewas, and Taluka-Nasarulaganj, Dist.- Sehore, Madhya Pradesh State  
*सर्वेक्षित क्षेत्र*
- 2. Total Area Mapped and Reported** : 35,005 ha हेक्टेयर  
*मैप किया गया क्षेत्रफल*
- 3. Base map used** : 1. High resolution satellite data on 1: 12,500 Scale  
*उच्च संकल्प उपग्रह छवि (मापक १:१२,५००)*  
2. Cadastral maps on 1: 4,000 Scale  
*ग्राम भूकर मानचित्र (मापक १:४,०००)*  
*उपयोग किये आधार नक्शे*
- 4. Geographical Location** : 22° 33'54" - 22° 58'22" उत्तर अक्षांश  
*भौगोलिक स्थिति*  
77° 00' 52" - 77° 21'27" पूर्व देशांतर
- 5. Kind of Survey** : Detailed Soil Survey *विस्तृत मृदा सर्वेक्षण*  
*सर्वेक्षण का प्रकार*
- 6. Period of Survey** : May' 2014 to June' 2014  
*सर्वेक्षण की अवधि*  
मई,२०१४ से जून,२०१४
- 7. Agro climatic Zone** : Central plateau and hill region (VIII)  
*आद्रता जलवायु क्षेत्र*  
मध्य पठार एवं पर्वत श्रेणी (ज़ोन-VIII)

**8. Soil Series wise area under different micro-watersheds** विभिन्न सूक्ष्म-जलग्रहण क्षेत्र एवं मृदा श्रेणी के अंतर्गत क्षेत्रफल :-

SERIES	Area (ha)	Area (%)	5D2D3g1	5D2D3g2	5D2D3g3	5D2D3g4	5D2D3g5	5D2D4a1	5D2D4a2	5D2D4a3	5D2D4a4	5D2D4b1	5D2D4b2	5D2D4b3	5D2D4b4	5D2D4c1	5D2D4c2	5D2D4c3	5D2D4h1	5D2D4h2
Chikhali	4007	11.4	-	-	-	-	-	285	32	191	-	-	-	-	-	206	495	41	431	226
Chipabad	1948	5.6	212	131	482	157	226	-	-	-	31	17	38	3	78	-	-	5	-	-
Kamtada	3075	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kapsi	1451	4.1	-	-	-	-	-	-	-	-	-	-	-	-	326	-	-	-	-	-
Khairi	21321	60.9	544	575	114	544	111	233	477	942	824	894	892	766	209	454	701	667	415	127
Pokharni	1972	5.6	-	-	136	51	332	-	-	-	18	229	-	91	68	-	-	-	-	-
Misc	1231	3.5	2	12	8	23	-	60	-	53	-	6	3	12	-	55	35	141	138	165
<b>Total</b>	<b>35005</b>	<b>100.0</b>	<b>758</b>	<b>718</b>	<b>740</b>	<b>775</b>	<b>669</b>	<b>578</b>	<b>509</b>	<b>1186</b>	<b>873</b>	<b>1146</b>	<b>933</b>	<b>872</b>	<b>681</b>	<b>715</b>	<b>1231</b>	<b>854</b>	<b>984</b>	<b>518</b>
%age	<b>100.0</b>		<b>2.2</b>	<b>2.1</b>	<b>2.1</b>	<b>2.2</b>	<b>1.9</b>	<b>1.7</b>	<b>1.5</b>	<b>3.4</b>	<b>2.5</b>	<b>3.3</b>	<b>2.7</b>	<b>2.5</b>	<b>1.9</b>	<b>2.0</b>	<b>3.5</b>	<b>2.4</b>	<b>2.8</b>	<b>1.5</b>

SERIES	5D2D4h3	5D2D4h4	5D2D4h5	5D2D4h6	5D2D4h7	5D2D4h8	5D2D4h9	5D2D4j1	5D2D4j2	5D2D4j3	5D2D4j4	5D2D4j5	5D2D4j6	5D2D4j7	5D2D4j8	5D2D4k1	5D2D4k2	5D2D4k3	5D2D4m1	5D2D5j1	5D2D5j2	5D2D6h1	5D2D6h2
Chikhali	410	-	-	136	71	-	22	731	-	99	47	-	12	120	139	165	1	124	23	-	-	-	-
Chipabad	-	-	-	-	-	-	-	-	-	-	-	97	49	-	-	-	200	27	151	44	-	-	-
Kamtada	-	-	-	-	-	-	-	-	-	-	-	169	23	-	-	-	57	54	561	134	331	798	948
Kapsi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54	58	27	-	152	454	380
Khairi	603	1013	877	500	722	610	1096	616	493	807	541	548	450	129	263	40	826	727	216	755	-	-	-
Pokharni	-	-	-	-	-	-	-	-	-	-	-	51	58	-	-	-	54	35	169	218	119	145	198
Misc	3	13	-	24	39	9	17	83	4	18	5	3	45	39	29	34	9	38	62	23	-	21	-
<b>Total</b>	<b>1016</b>	<b>1026</b>	<b>877</b>	<b>660</b>	<b>832</b>	<b>619</b>	<b>1135</b>	<b>1430</b>	<b>497</b>	<b>924</b>	<b>593</b>	<b>868</b>	<b>637</b>	<b>288</b>	<b>431</b>	<b>239</b>	<b>1201</b>	<b>1063</b>	<b>1209</b>	<b>1174</b>	<b>602</b>	<b>1418</b>	<b>1526</b>
%age	<b>2.9</b>	<b>2.9</b>	<b>2.5</b>	<b>1.9</b>	<b>2.4</b>	<b>1.8</b>	<b>3.2</b>	<b>4.1</b>	<b>1.4</b>	<b>2.6</b>	<b>1.7</b>	<b>2.5</b>	<b>1.8</b>	<b>0.8</b>	<b>1.2</b>	<b>0.7</b>	<b>3.4</b>	<b>3.0</b>	<b>3.5</b>	<b>3.4</b>	<b>1.7</b>	<b>4.1</b>	<b>4.4</b>

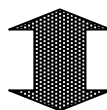
9. **Micro-watersheds wise Distribution of Area under various Land Capability Classes:**  
**विभिन्न भूमि क्षमता वर्गीकरण एवं सूक्ष्म-जलग्रहण क्षेत्र के अंतर्गत क्षेत्रफल:-**

Land Capability Unit	Area (ha)	Area (%)	5D2D3g1	5D2D3g2	5D2D3g3	5D2D3g4	5D2D3g5	5D2D4a1	5D2D4a2	5D2D4a3	5D2D4a4	5D2D4b1	5D2D4b2	5D2D4b3	5D2D4b4	5D2D4c1	5D2D4c2	5D2D4c3	5D2D4h1	5D2D4h2
IIs1	634	1.8	-	4	27	9	-	29	-	-	149	177	38	-	-	71	-	-	35	30
IIses1	13303	38.0	355	371	329	484	259	51	281	364	298	429	449	332	113	180	239	63	40	94
IIIses1	8859	25.3	290	242	194	166	11	256	171	556	250	190	372	342	139	234	441	460	414	47
IIIses2	818	2.3	-	-	58	-	179	-	-	-	-	65	-	-	14	-	-	-	-	-
IIIses3	1134	3.2	-	-	78	51	153	-	-	-	18	164	-	71	54	-	-	-	-	-
IVes1	4420	12.6	111	89	46	42	67	182	57	213	158	115	71	115	35	175	516	190	357	182
IVes2	533	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IVes3	80	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VIses1	196	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forest	3797	10.8	-	-	-	-	-	-	-	-	-	-	-	-	326	-	-	-	-	-
Misc.	1231	3.5	2	12	8	23	-	60	-	53	-	6	3	12	-	55	35	141	138	165
<b>Total</b>	<b>35005</b>	<b>100</b>	<b>758</b>	<b>718</b>	<b>740</b>	<b>775</b>	<b>669</b>	<b>578</b>	<b>509</b>	<b>1186</b>	<b>873</b>	<b>1146</b>	<b>933</b>	<b>872</b>	<b>681</b>	<b>715</b>	<b>1231</b>	<b>854</b>	<b>984</b>	<b>518</b>
% age	<b>100.0</b>		<b>2.2</b>	<b>2.1</b>	<b>2.1</b>	<b>2.2</b>	<b>1.9</b>	<b>1.7</b>	<b>1.5</b>	<b>3.4</b>	<b>2.5</b>	<b>3.3</b>	<b>2.7</b>	<b>2.5</b>	<b>1.9</b>	<b>2.0</b>	<b>3.5</b>	<b>2.4</b>	<b>2.8</b>	<b>1.5</b>

Land Capability Unit	5D2D4h3	5D2D4h4	5D2D4h5	5D2D4h6	5D2D4h7	5D2D4h8	5D2D4h9	5D2D4j1	5D2D4j2	5D2D4j3	5D2D4j4	5D2D4j5	5D2D4j6	5D2D4j7	5D2D4j8	5D2D4k1	5D2D4k2	5D2D4k3	5D2D4m1	5D2D5j1	5D2D5j2	5D2D6h1	5D2D6h2	5D2D6h2
IIs1	32	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IIs1	304	706	644	328	517	387	857	475	284	654	372	508	373	108	253	24	623	395	342	418	-	-	-	-
IIIs1	503	268	200	211	222	223	261	298	154	150	193	42	118	81	89	94	278	396	41	262	-	-	-	-
IIIs2	-	-	-	-	-	-	-	-	-	-	-	3	22	-	-	-	6	11	96	167	62	53	82	198
IIIs3	-	-	-	-	-	-	-	-	-	-	-	48	36	-	-	-	48	24	73	51	57	92	116	-
IVes1	174	39	-	97	54	-	-	494	55	102	23	95	20	60	60	87	126	87	7	119	-	-	-	-
IVes2	-	-	-	-	-	-	-	-	-	-	-	65	1	-	-	-	15	53	46	28	87	27	211	211
IVes3	-	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36
VIs1	-	-	-	-	-	-	-	-	-	-	-	13	22	-	-	-	42	1	-	13	69	-	36	1081
Forest	-	-	-	-	-	-	-	-	-	-	-	91	-	-	-	-	54	58	542	93	327	1225	1081	-
Misc.	3	13	-	24	39	9	17	83	4	18	5	3	45	39	29	34	9	38	62	23	-	21	-	1526
<b>Total</b>	<b>1016</b>	<b>1026</b>	<b>877</b>	<b>660</b>	<b>832</b>	<b>619</b>	<b>1135</b>	<b>1430</b>	<b>497</b>	<b>924</b>	<b>593</b>	<b>868</b>	<b>637</b>	<b>288</b>	<b>431</b>	<b>239</b>	<b>1201</b>	<b>1063</b>	<b>1209</b>	<b>1174</b>	<b>602</b>	<b>1418</b>	<b>1526</b>	<b>3052</b>
% age	2.9	2.9	2.5	1.9	2.4	1.8	3.2	4.1	1.4	2.6	1.7	2.5	1.8	0.8	1.2	0.7	3.4	3.0	3.5	3.4	1.7	4.1	4.4	8.7

**10. Micro-watersheds wise Distribution of Area under various Erosion Classes** विभिन्न भू-क्षरण वर्गों एवं सूक्ष्म-जल ग्रहण क्षेत्रों के अंतर्गत क्षेत्रफल:

Erosion class	Area (ha)	Area (%)	5D2D3g1	5D2D3g2	5D2D3g3	5D2D3g4	5D2D3g5	5D2D4a1	5D2D4a2	5D2D4a3	5D2D4a4	5D2D4b1	5D2D4b2	5D2D4b3	5D2D4b4	5D2D4c1	5D2D4c2	5D2D4c3	5D2D4h1	5D2D4h2
None to slight erosion (e1)	634	1.8	-	4	27	9	-	29	-	-	149	177	38	-	-	71	-	-	35	30
Moderate erosion (e2)	25008	71.4	645	613	659	701	602	307	452	920	566	848	821	745	320	414	680	523	454	141
Severe erosion (e3)	8132	23.2	111	89	46	42	67	182	57	213	158	115	71	115	361	175	516	190	357	182
Misc.	1231	3.5	2	12	8	23	-	60	-	53	-	6	3	12	-	55	35	141	138	165
<b>Total</b>	<b>35005</b>	<b>100</b>	<b>758</b>	<b>718</b>	<b>740</b>	<b>775</b>	<b>669</b>	<b>578</b>	<b>509</b>	<b>1186</b>	<b>873</b>	<b>1146</b>	<b>933</b>	<b>872</b>	<b>681</b>	<b>715</b>	<b>1231</b>	<b>854</b>	<b>984</b>	<b>518</b>
% age	100.0		2.2	2.1	2.1	2.2	1.9	1.7	1.5	3.4	2.5	3.3	2.7	2.5	1.9	2.0	3.5	2.4	2.8	1.5



Erosion class	5D2D4h3	5D2D4h4	5D2D4h5	5D2D4h6	5D2D4h7	5D2D4h8	5D2D4h9	5D2D4j1	5D2D4j2	5D2D4j3	5D2D4j4	5D2D4j5	5D2D4j6	5D2D4j7	5D2D4j8	5D2D4k1	5D2D4k2	5D2D4k3	5D2D4m1	5D2D5j1	5D2D5j2	5D2D6h1	5D2D6h2
None to slight erosion (e1)	32		33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moderate erosion (e2)	807	974	844	539	739	610	1118	773	438	804	565	666	550	189	342	118	970	879	696	926	232	277	541
Severe erosion (e3)	174	39	-	97	54	-	-	574	55	102	23	199	42	60	60	87	222	146	451	225	370	1120	985
Misc.	3	13		24	39	9	17	83	4	18	5	3	45	39	29	34	9	38	62	23	-	21	-
<b>Total</b>	<b>1016</b>	<b>1026</b>	<b>877</b>	<b>660</b>	<b>832</b>	<b>619</b>	<b>1135</b>	<b>1430</b>	<b>497</b>	<b>924</b>	<b>593</b>	<b>868</b>	<b>637</b>	<b>288</b>	<b>431</b>	<b>239</b>	<b>1201</b>	<b>1063</b>	<b>1209</b>	<b>1174</b>	<b>602</b>	<b>1418</b>	<b>1526</b>
% age	2.9	2.9	2.5	1.9	2.4	1.8	3.2	4.1	1.4	2.6	1.7	2.5	1.8	0.8	1.2	0.7	3.4	3.0	3.5	3.4	1.7	4.1	4.4

**11. Series wise Distribution of Area under various Land Capability Classes** विभिन्न भूमि क्षमता वर्गीकरण अंतर्गत आने वाले क्षेत्र की मृदा श्रेणी के अंतर्गत वितरण:

Land Capability Unit	Area (ha)	Area (%)	Others	Chikhali	Chipabad	Kamtada	Kapsi	Khairi	Pokharni
Iles1	13303	38.0	-	-	1192	-	-	12111	-
IIs1	634	1.8	-	-	35	-	-	599	-
IIIs1	8859	25.3	-	1446	654	-	-	6759	-
IIIs2	818	2.3	-	-	-	-	-	-	818
IIIs3	1134	3.2	-	-	-	-	-	-	1134
IVes1	4420	12.6	-	2481	67	-	-	1852	20
IVes2	533	1.5	-	-	-	533	-	-	-
IVes3	80	0.2	-	80	-	-	-	-	-
VIs1	196	0.6	-	-	-	196	-	-	-
Misc	1231	3.5	1231	-	-	-	-	-	-
Forest	3797	10.8	-	-	-	2346	1451	-	-
<b>Total</b>	<b>35005</b>	<b>100</b>	<b>1231</b>	<b>4007</b>	<b>1948</b>	<b>3075</b>	<b>1451</b>	<b>21321</b>	<b>1972</b>
<b>% age</b>	<b>100.0</b>		<b>3.5</b>	<b>11.4</b>	<b>5.6</b>	<b>8.8</b>	<b>4.1</b>	<b>60.9</b>	<b>5.6</b>

## 12. Salient features मुख्य विशेषताएं:

- ❖ Out of the total surveyed area of 35,005 ha about 72.4 % (25,328 ha) is occupied by very deep soils, 5.6 % (1,948 ha) is occupied by deep soils and 18.5 % (6,498 ha) area under shallow to moderately deep soils.

कुल सर्वेक्षित क्षेत्र का ७२.४ % (२५,३२८ हेक्टेयर ) अति गहरी भूमि, ५.६ % (१,९४८ हेक्टेयर ) गहरी भूमि तथा १८.५ % (६,४९८ हेक्टेयर ) उथली से मध्यम गहरी भूमि हैं।

- ❖ An area of 4.1 % (1,451 ha) of total reported area occurs on strong to moderate steep sloping landforms. About 1.4 % (476 ha) occurs on moderate slope and about 48.8 % (17,092 ha) is under gentle slopes. An area of 1.8 % (634 ha) is covered by terraced lands and 40.3 % (14,121 ha) area have Very gentle slope.

कुल सर्वेक्षण में ४.१ % (१,४५१ हेक्टेयर) क्षेत्र तीव्र से मध्यम खड़ी ढलान भू आकृतियों हैं। लगभग १.४ % (४७६ हेक्टेयर) मध्यम ढलान के अंतर्गत और ४८.८ % (१७,०९२ हेक्टेयर) कम ढलान वाली है। १.८% (६३४ हेक्टेयर) क्षेत्र कम ढलान पर सीढ़ीदार भूमि है तथा २३.८% (९,२३५ हेक्टेयर) बहुत कम ढलान पर सीढ़ीदार भूमि है और ४०.३ % (१४,१२१ हेक्टेयर) क्षेत्र बहुत कम ढलान ढाल वाली है।

- ❖ About 71.4 % (25,008 ha) of total area suffers from moderate erosion hazards and a large area of 23.2 % (8,132 ha) area suffers from severe erosion which needs immediate attention for soil and water conservation measures.

कुल क्षेत्रफल का लगभग ७१.४ % (२५,००८ हेक्टेयर) मध्यम भू-क्षरण से प्रभावित है और बड़ा क्षेत्र २३.२ % (८,१३२ हेक्टेयर) गंभीर भू-क्षरण से प्रभावित है जिसमें मिट्टी के स्वास्थ्य और अवनति रोकने के लिए निगरानी की जरूरत है।

- ❖ The bushy forest area which is subjected to unabated degradation due to illicit felling of trees/bushes needs immediate attention for afforestation programme, besides taking proper soil-water conservation measures.

पेड़ / झाड़ियों की अवैध कटाई के कारण जंगली वन क्षेत्र निरंतर भू-क्षरण के अधीन है जिसे उचित मिट्टी-जल संरक्षण के उपाय की जरूरत है, इसके अलावा, वनीकरण कार्यक्रम के लिए तत्काल ध्यान देने की जरूरत है।

## HOW TO USE SOIL SURVEY REPORT

The present report furnishes a detailed account of various characteristics of the surveyed area, like physiography, relief, geology, climate, natural vegetation, land use and soils. Description of the soil series recognized in the area, like detailed information on soil characteristics, classification, potentialities and limitations are given in the report. Interpretations of different soil mapping units for various applied aspects of agricultural development such as land use plans, soil and water management, soil conservation plans, identification of areas for afforestation, engineering applications, and eco-restoration and waste-land management have been given in different chapters. Different problems of the area have also been depicted and their corrective measures are thereby suggested. Soil survey interpretations for land capability class, soil and land irrigability class, hydrological grouping and paddy grouping are described in chapter 7.

In order to use the report, the user will locate the area of interest on the soil map appended with the report. Permanent features like roads, village sites, streams and ponds etc. would help for location of specific area. On the map each soil unit has been delineated and represented by symbolic expression dealing with all technical description. The abbreviated symbol of mapping unit shows information about the name of soil series, soil depth, soil texture, land slope gradient, erosion condition and land surface features like gravelliness, stoniness or rockiness. It refers to a particular type of soil for example KP2k\_E3SRF that represents KP- Kapsi series, 2- Shallow , k\_ Sandy clay loam texture of surface, E- Strong slope (10-15%]', 3 Sever erosion, S- Stoniness, R- Rockiness F-Forest Details of the soil mapping unit with description, extent in each micro-watershed and their multipurpose interpretations (like land capability units, soil and land irrigability classes, paddy soil grouping, hydrological grouping etc) have been shown in appendix I (Guide to soil mapping units).

The differentiating characteristics of soil series are furnished in table 5 and the typifying pedon of soil series are described in Appendix II where detailed description of soils and morphological description of representative soil profiles along with their analytical data are given. Village wise mapping units, their area extent, and present land use and management status, physiography, predominant slope, land use and land capability classification etc. are given in Appendix III.

For any clarification and comments, correspondence may be made to

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## 1. Introduction

The detailed soil survey aims at studying soil and land resources in detail for soil resource inventory, classification and mapping of soils for Soil Conservation and Integrated Land Use Management Planning under National Watershed Development Programme at micro level.

In view of developing the strategic plan for soil and water conservation and efficient land management in some selected area of very high and high priority micro watersheds i.e of “5D2D3g1 to g5, D4a1 to a4, D4b1 to b4, D4c1 to c3, D4h1 to h9, D4j1 to j8, D4k1 to k3, D4m1, D5j1 to j2 and D6h1 to h2” of Narmada Catchment (RVP) during November 2014 to January 2015 by Nagpur Regional Centre of Soil and Land Use Survey of India, Ministry of Agriculture & Farmers’ welfare, Govt. of India. The objective in selecting high and very high priority microwatersheds is to check the accelerated soil erosion in vulnerable areas and to minimize the sediment load in Narmada Catchment (RVP)

The report embodies detailed information on soil and land of the area, comprising morphological, physical and chemical properties of soils coupled with various soil interpretation classes that help to evaluate soil potentials, suitability and limitations as well. The utility of detailed data base is enhanced by interpretation of soil and land information into different land capability units, soil irrigability units and land irrigability units, hydrological Soil grouping to assess the runoff generation potential of particular soil type and soil suitability classification for various crops and Paddy soil grouping.

The detailed soil survey in various micro-watersheds of Narmada catchment was undertaken using high resolution satellite data on 1: 12,500 scale with the following objectives.

- ❖ To study, identify and map different type of soil series and their phases.
- ❖ To classify soil series and their phases into different interpretative grouping based on their potential and limitation to assess suitability for sustainable agricultural development.
- ❖ To make available soil information on GIS platform so that the soil data can be manipulated for extraction of various theme based information as designed by user agencies.

## **2. General Description of The Area**

### **2.1. Location and Extent:**

The survey area comprising “5D2D3g1 to g5, D4a1 to a4, D4b1 to b4, D4c1 to c3, D4h1 to h9, D4j1 to j8, D4k1 to k3, D4m1, D5j1 to j2 and D6h1 to h2” micro-watersheds of Narmada Catchment are located between 22° 34' - 22° 59' N Latitude 77° 02' - 77° 22' E Longitude falling in Taluka-Khategaon, Dist.- Dewas, and Taluka-Nasarulaganj, Dist.- Sehore, Madhya Pradesh State., It is covered by the Survey of India topographical maps no. 55F/1, 55F/2, 55F/5.

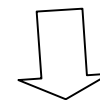
The district is situated 302 m higher from the sea level. The location map of surveyed area is shown in Fig-1. The names of villages falling under each micro- watersheds with their area surveyed are furnished in Table 1.

**Table - 1: List of Villages and their area falling under different micro-watersheds:**

VILLAGE NAME	Area (ha)	Area (%)	5D2D3g1	5D2D3g2	5D2D3g3	5D2D3g4	5D2D3g5	5D2D4a1	5D2D4a2	5D2D4a3	5D2D4a4	5D2D4b1	5D2D4b2	5D2D4b3	5D2D4b4	5D2D4c1	5D2D4c2	5D2D4c3	5D2D4h1	5D2D4h2
Ambah	501	1.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atraliya	202	0.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Badnagar	610	1.74	-	-	-	-	-	-	130	20	-	-	-	-	-	-	-	332	-	-
Bagwara	654	1.87	-	-	-	-	-	79	-	575	-	-	-	-	-	-	-	-	-	-
Bain	563	1.62	-	-	-	-	-	-	-	-	-	-	541	22	-	-	-	-	-	-
Baisad	221	0.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bajgaon	519	1.49	-	-	514	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Balagaon	706	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	256	-	-	-
Bankat	21	0.06	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-
Bhadkui	97	0.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bhilai	309	0.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bijla	226	0.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Borda	943	2.69	82	671	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bori	334	0.95	-	-	36	-	135	-	-	-	-	-	163	-	-	-	-	-	-	-
Borkheda Khurd	1796	5.15	-	-	-	-	-	-	-	-	-	-	-	327	20	-	43	-	-	-
Chaurasa Khedi	234	0.67	-	-	-	-	-	234	-	-	-	-	-	-	-	-	-	-	-	-
Chhitgaon Moji	35	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chichali	269	0.76	-	-	-	-	-	-	-	-	-	-	74	195	-	-	-	-	-	-
Dhannas	254	0.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dholpur	658	1.88	-	-	-	-	-	239	-	-	-	-	-	-	-	419	-	-	-	-
Dobhan	545	1.58	-	-	-	9	-	-	-	-	201	335	-	-	-	-	-	-	-	-
Ganora	91	0.26	-	-	-	-	-	-	-	-	-	-	-	91	-	-	-	-	-	-
Gilehari	268	0.77	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-	240	-	-
Gillor	797	2.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223	-	-	-
Gopalpur	1325	3.8	-	-	-	559	12	-	-	-	86	-	-	-	-	-	-	-	-	-

VILLAGE NAME	Area (ha)	Area (%)	5D2D3g1	5D2D3g2	5D2D3g3	5D2D3g4	5D2D3g5	5D2D4a1	5D2D4a2	5D2D4a3	5D2D4a4	5D2D4b1	5D2D4b2	5D2D4b3	5D2D4b4	5D2D4c1	5D2D4c2	5D2D4c3	5D2D4h1	5D2D4h2
Gorkhpur	410	1.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habibnagar	306	0.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haliakhedi	980	2.81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	592	-	-	-
Hamidganj	13	0.04	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-
Itarsi	183	0.53	-	-	-	-	-	-	-	134	49	-	-	-	-	-	-	-	-	-
Itawa Katan	868	2.46	-	-	-	-	-	-	-	457	401	-	-	-	-	-	-	10	-	-
Jamonia Kalan	446	1.26	-	-	-	-	-	26	166	-	-	-	-	-	-	254	-	-	-	-
Jhali	470	1.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jhirnia	375	1.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kharda	723	2.06	676	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kharsaniya Kalan	658	1.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kumantal	922	2.64	-	-	-	-	517	-	-	-	-	314	91	-	-	-	-	-	-	-
Lanchor	12	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Larkui	1214	3.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mahagoan	674	1.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mandi	99	0.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mariadoh	297	0.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muhai Kalan	885	2.52	-	-	-	-	-	-	-	-	-	-	-	224	661	-	-	-	-	-
Nandkot	334	0.95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	117	-	-	-
Nasrullaganj	142	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nawalgoan	180	0.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nimnagoan	853	2.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nimota	768	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palasi Kalan	696	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pandagoan	466	1.34	-	-	-	-	-	-	192	-	-	-	-	-	-	42	-	232	-	-

VILLAGE NAME	Area (ha)	Area (%)	5D2D3g1	5D2D3g2	5D2D3g3	5D2D3g4	5D2D3g5	5D2D4a1	5D2D4a2	5D2D4a3	5D2D4a4	5D2D4b1	5D2D4b2	5D2D4b3	5D2D4b4	5D2D4c1	5D2D4c2	5D2D4c3	5D2D4h1	5D2D4h2
R.Forest	2944	8.41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Richhariya	497	1.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rujankhedi	360	1.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Satdev	592	1.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	592	-
Seelkanth	535	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	155	380
Semalpani	1054	3.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sewania	626	1.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shampur	516	1.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sigoan	207	0.58	-	-	-	207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Singpur	705	2.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sohankhedi	448	1.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63	20
Sonthiya	80	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sukarwas	361	1.02	-	-	-	-	-	-	-	-	-	318	43	-	-	-	-	-	-	-
Suned	281	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tigali	292	0.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	174	118
Vasudeo	355	1.03	-	-	-	-	-	-	-	-	136	179	-	-	-	-	-	40	-	-
<b>Total</b>	<b>35005</b>	<b>100.1</b>	<b>758</b>	<b>718</b>	<b>740</b>	<b>775</b>	<b>669</b>	<b>578</b>	<b>509</b>	<b>1186</b>	<b>873</b>	<b>1146</b>	<b>933</b>	<b>872</b>	<b>681</b>	<b>715</b>	<b>1231</b>	<b>854</b>	<b>984</b>	<b>518</b>



VILLAGE_NAME	5D2D4h3	5D2D4h4	5D2D4h5	5D2D4h6	5D2D4h7	5D2D4h8	5D2D4h9	5D2D4j1	5D2D4j2	5D2D4j3	5D2D4j4	5D2D4j5	5D2D4j6	5D2D4j7	5D2D4j8	5D2D4k1	5D2D4k2	5D2D4k3	5D2D4m1	5D2D5j1	5D2D5j2	5D2D6h1	5D2D6h2
Ambah	-	-	-	-	-	-	-	-	-	-	116	92	-	-	234	-	-	-	59	-	-	-	-
Atraliya	190	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Badnagar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	128	-	-	-	-	-	-	-
Bagwara	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baisad	-	-	-	-	-	-	-	-	3	218	-	-	-	-	-	-	-	-	-	-	-	-	-
Bajgaon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balagaon	134	-	-	316	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bhadkui	-	-	-	-	-	-	-	-	-	78	19	-	-	-	-	-	-	-	-	-	-	-	-
Bhilai	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	244	65	-	-
Bijla	-	-	226	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Borda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bori	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Borkheda Khurd	-	139	295	-	698	27	247	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaurasa Khedi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chhitgaon Moji	-	-	15	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chichali	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dhannas	-	-	-	-	-	-	67	-	172	15	-	-	-	-	-	-	-	-	-	-	-	-	-
Dholpur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dobhan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ganora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gilehari	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-
Gillor	-	-	-	-	82	-	-	492	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gopalpur	-	-	-	-	-	-	-	-	-	270	383	15	-	-	-	-	-	-	-	-	-	-	-

VILLAGE_NAME	5D2D4h3	5D2D4h4	5D2D4h5	5D2D4h6	5D2D4h7	5D2D4h8	5D2D4h9	5D2D4j1	5D2D4j2	5D2D4j3	5D2D4j4	5D2D4j5	5D2D4j6	5D2D4j7	5D2D4j8	5D2D4k1	5D2D4k2	5D2D4k3	5D2D4m1	5D2D5j1	5D2D5j2	5D2D6h1	5D2D6h2
Gorkhpur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104	247	59	-	-	-	-	-
Habibnagar	-	-	-	-	-	-	-	-	-	-	-	61	-	-	-	-	-	-	245	-	-	-	-
Haliakhedi	-	-	-	344	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hamidganj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Itarsi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Itawa Katan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamonia Kalan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jhali	-	-	-	-	-	-	-	-	-	-	-	163	167	-	-	-	-	-	13	113	14	-	-
Jhirnia	-	-	-	-	-	-	-	-	-	85	7	-	-	86	197	-	-	-	-	-	-	-	-
Kharda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kharsaniya Kalan	-	-	136	-	-	-	522	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kumantal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lanchor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-
Larkui	-	-	-	-	-	-	-	-	-	-	32	449	470	-	-	-	-	-	-	263	-	-	-
Mahagoan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	242	432	-	-	-	-	-
Mandi	99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mariadoh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	297	-	-	-
Muhai Kalan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nandkot	217	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nasrullaganj	-	-	142	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nawalgoan	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	150	-	22	-	-
Nimnagoan	-	-	12	-	-	484	271	-	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nimota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	196	572	-	-	-	-	-
Palasi Kalan	-	-	-	-	-	-	-	-	236	258	-	-	-	202	-	-	-	-	-	-	-	-	-
Pandagoan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

VILLAGE_NAME	5D2D4h3	5D2D4h4	5D2D4h5	5D2D4h6	5D2D4h7	5D2D4h8	5D2D4h9	5D2D4j1	5D2D4j2	5D2D4j3	5D2D4j4	5D2D4j5	5D2D4j6	5D2D4j7	5D2D4j8	5D2D4k1	5D2D4k2	5D2D4k3	5D2D4m1	5D2D5j1	5D2D5j2	5D2D6h1	5D2D6h2
R.Forest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1418	1526
Richhariya	11	486	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rujankhedi	-	309	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Satdev	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seelkanth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Semalpani	-	-	-	-	8	108	-	938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sewania	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	125	-	501	-	-
Shampur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	516	-	-	-	-	-	-
Sigoan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Singpur	-	-	-	-	-	-	-	-	-	-	-	88	-	-	-	-	-	-	617	-	-	-	-
Sohankhedi	365	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sonthiya	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sukarwas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Suned	-	-	-	-	-	-	-	-	-	-	36	-	-	-	-	-	-	-	-	245	-	-	-
Tigali	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vasudeo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>1016</b>	<b>1026</b>	<b>877</b>	<b>660</b>	<b>832</b>	<b>619</b>	<b>1135</b>	<b>1430</b>	<b>497</b>	<b>924</b>	<b>593</b>	<b>868</b>	<b>637</b>	<b>288</b>	<b>431</b>	<b>239</b>	<b>1201</b>	<b>1063</b>	<b>1209</b>	<b>1174</b>	<b>602</b>	<b>1418</b>	<b>1526</b>



## 2.2. Physiography, Relief And Drainage:

The survey area is a part of Malwa Plateau and alluvial plains of Narmada River. The Malwa plateau is formed from Basaltic rocks, which is the parent materials for deep black soils developed in the area.

Similarly very deep black soils are also deposited along big nala and river through the alluvial deposits. The slope range of both basaltic plateau plain and alluvial plain is in between 0 to 5 %. The undulating plain with 3 to 10 % slope found in basaltic landscape.

The survey area is drained by many streams and small rivers from North East to South West direction. These drains ultimately join to Narmada River. The drainage pattern is subdendritic in undulating plains to sub parallel in alluvial plains.

The broad landscapes of the area with physiographic units are given below.

**Table – 2. Landscapes of the area**

Landscapes	Physiography	Slope	Series
Alluvium	Alluvial plains	Nearly Level to Gentle Sloping	Khairi (KH)
	Stream banks	Gentle slope to Moderate sloping	Chikhali (C)
Basalts	Plateau Plains	Nearly Level to Gentle Sloping	Chipabad (CH) Pokharni (PR)
		Gentle to Moderate Sloping	Kamtada (KM)
	Side slope of hills	Strong to moderate steep Sloping	Kapsi (KP)

The elevation of subwatershed range from 260 to 360 m above mean sea level (msl). The subwatersheds are drained by Kolar, Sip .Ajnal and Dagaria nalla/nadi directly into Narmada River.

### **2.3. Geology:**

Geologically, the area is characterized by Deccan trap with formation of basalt, Basalts is dark coloured, fine to medium grained, basic igneous rock and is composed of mainly plagioclase, pyroxene, irons ore etc. The most striking peculiarity of the basalt is the prevalence of vesicular characters'. The presence of green mineral is an important characteristic of the area.

The stratigraphical studies carried out by Geological Survey of India reveal that the basement rock is granite-gniess which is exposed on ground surface at place.

Alluvium of sub-recent to recent period known as khadar is consisting of coarse sediments deposited by fluvial action of the river and streams of the area and generally occur as flood plain.

The older alluvium of middle Pleistocene period known as Bhangar is made up of finer sediments deposited by river and generally occurs as alluvial plain.

### **2.4. Climate:**

The climate in general is tropical monsoonal type which is characterized by mild winter and hot summer season. The climate on the whole is dry except during monsoon season. The winter season starts from December to February and is followed by summer from March to May. The South-West monsoon follows thereafter and lasts till September. October & November constitute the post monsoon season.

The mean annual precipitation recorded at Indore is 882.0 mm of which 92% rain is received during June to September. The mean minimum temperature and maximum temperature are 17.7°C and 31.3°C, respectively. The mean annual temperature (MAT) is 24.5°C. The mean summer temperature and mean winter temperature are 27.2°C and 18.8 °C, respectively with a difference of 8.4°C. Thus, the soils of the area fall under hyperthermic temperature regime.

The meteorological data are presented in Table-3. The Ombrothermic diagram and temperature deviation curve are shown in Fig.-2 and 3 respectively Ombrothermic diagram shows that most of the soils remain moist for the months June to October, which is about 120 days hence the survey area has Ustic soil moisture regime.

**Table-3: Meteorological Data of Indore Distt. (M.P.) from 1948-1988**

S. No.	Months	Average Rainfall (mm)	Temperature (°C)		Mean Monthly Temperature (°C)
			Maximum	Minimum	
1	January	6.1	26.7	10.0	18.3
2	February	3.6	28.3	11.1	19.7
3	March	2.0	33.3	15.6	24.4
4	April	3.3	37.8	21.1	29.4
5	May	13.0	39.4	24.4	31.9
6	June	147.3	35.6	24.4	30.0
7	July	282.5	29.4	22.8	26.1
8	August	207.0	28.3	21.7	25.0
9	September	164.1	29.4	21.1	25.3
10	October	30.7	31.7	17.2	24.4
11	November	15.5	28.9	12.8	20.8
12	December	6.9	26.7	10.0	18.3
<b>Total</b>		<b>882.0</b>	<b>31.3</b>	<b>17.7</b>	<b>24.5</b>

Source: - Worldwide Bioclimatic Classification system, Spain

- Total Annual Rainfall : 882.0 mm
- Mean Annual Air Temperature : 24.5°C
- Mean Annual Summer Temperature : 27.0°C  
(June, July, August)
- Mean Annual Winter Temperature : 18.8°C  
(December, January, February)
- Difference between summer temp. and mean winter temp : 8.2°C
- Temperature Regime : Hyperthermic
- Moisture region : Ustic

## 2.5. Natural Vegetation:

The natural vegetation of the area is of dry deciduous nature and falls under dry deciduous tropical forest as per champion classifications. The moderate rainfall and high temperature have significant influence on the nature of vegetation in the area. It comprises trees, shrubs, grasses of xerophytic species. Some of the common species observed in the area are as under.

Sl. No.	Local Name	Botanical Name
<b>Trees</b>		
1	Babul	<u><i>Acacia arabica</i></u>
2	Khair	<u><i>Acacia catechu</i></u>
3	Dhow	<u><i>Anogeissus latifolia</i></u>
4	Neem	<u><i>Anadirachata indica</i></u>
5	Bel	<u><i>Aegle marmelos</i></u>
6	Hivar	<u><i>Acacia leucopholea</i></u>
7	Salai	<u><i>Boswellia serrata</i></u>
8	Amita	<u><i>Bauhinia malabarica</i></u>
9	Palas	<u><i>Butea monosperma</i></u>
10	Shisam	<u><i>Delbergia latifolia</i></u>
11	Pipal	<u><i>Ficus religiosa</i></u>
12	Badh	<u><i>Ficus bengalensis</i></u>
13	Jamun	<u><i>Eugenia jambolana</i></u>
14	Seja	<u><i>Lagarstroemia parviflora</i></u>
15	Aam	<u><i>Manqifera indica</i></u>
16	Mahua	<u><i>Madhuca latifolia</i></u>
17	Tinasa	<u><i>Ougeinia coieinesis</i></u>
18	Date palm	<u><i>Phoenix ductylifera</i></u>
19	Sal	<u><i>Shorea robusta</i></u>
20	Jamun	<u><i>Syzegium cumunii</i></u>
21	Imli	<u><i>Tamrindus indica</i></u>
22	Sagwan (Teak)	<u><i>Tectona grandis</i></u>
<b>Shrubs</b>		
1	Karonda	<u><i>Caressa phinarum</i></u>
2	Nagphani	<u><i>Cactus sps.</i></u>
3	Khakara	<u><i>Butea frondosa</i></u>
4	Chaneri	<u><i>Lantana camera</i></u>
5	Tulsi	<u><i>Occimum sanctum</i></u>
6	Nirgudi	<u><i>Vitex negundu</i></u>
7	Ber	<u><i>Zizyphus jujuba</i></u>
<b>Grasses</b>		
1	Phuli	<u><i>Apluda aristata</i></u>
2	Harayali	<u><i>Cynodon dactylon</i></u>
3	Rusa	<u><i>Cymbo pogonmartini</i></u>
4	Kusal	<u><i>Heteropogon contortus</i></u>
5	Subai grass	<u><i>Eulaliliopsis binata</i></u>

## **2.6. Water Supply, Quality and Source:**

The main source of water supply is through tube well, wells, tanks and reservoirs. Lift irrigation is practiced in area situated on the bank of Narmada River. Village situated on the bank of river, use water for daily consumption in summer months. The quality of water is good.

## **2.7. Socio-Economic Condition:**

The main occupation is farming. The supplementary works are dairying, cattle rearing, carpentry, which are popular and profitable business in the area.

The communication facilities much as, state high way Hasangabad and Bhopal to Khategaon passes through the survey area and most of the villages are connected to the state highway through approach roads.

Every major village on the road has post office, high school and other public amenities. There is electricity in some villages and higher education facilities are available in Khategaon & Nasarulaganj tehsil. Some facilities such as primary health centres and veterinary clinic are available at Khategaon & Nasarulaganj. Marketing facilities are also available at both taluka places. Harda is well connected by road and rail to the survey area, to the state capital, Bhopal which is about 168 kms away from area. All three Block Headquarters namely Nasarulaganj and Khategaon are well connected by road and rail.

Harda mandi is named as Adarsh Krishi Upaj Mandi and farmer take their agricultural produce for sale to this mandi.

### 3. Present Land Use and Agriculture:

#### 3.1. Present Land Use:

The present land use pattern of the villages of the survey area is given in Table-5. It may be seen that 81.4 % area is net cultivated and 71.9.% area is under double cropping. Fallow lands (both current and old fallow), under other grass lands cover 6.2 % & 4.3%, respectively. Forest, Hills/Plateau are spread over 3.8 % area of restricted and their surrounding lands. The remaining area is under public utility i.e. village situation, road, river, Nallas and under submergence etc.

#### 3.2. Agriculture and Management Practices:

Primitive and traditional agronomic practices are adopted by the farmers of the survey area. Some improved agronomic practices are also adopted wherever irrigation facilities are available. The common adopted crops rotation as used by the cultivators of the area is given below. Major crop variety grown in surveyed area and agriculture and management practices given in Table-4

<i>Kharif</i>	<i>Rabi</i>
Soyabean	Wheat/gram
Soyabean/Maize	Lentle
Paddy/Tur	Gram/Moong

#### 3.3. Crops Sowing period:

The surveyed area have major area under double cropping system. The soyabean crop is widely sown in kharif season which starts around mid June to mid July. However, Maize, Jowar, Paddy are also cultivated in this season in small patches.

**Table- 4:- Popular Variety grown in surveyed area & Agronomic measures:-**

Season	Normal Crop / Cropping system	Change in crop / cropping system including variety	Agronomic measures
<b>Kharif</b>	Soybean	JS-93-05, JS 95-60	<ul style="list-style-type: none"> <li>•Seed dressing with Thiram + carbendazim in equal ratio @3g/kg seed</li> <li>• Use biofertilizer (Rhizobium culture)</li> <li>• Planting on ridge and furrow system</li> <li>• 25 % higher seed rate</li> </ul>
	Maize	Maize (JM-216, JM-8, JM-12)	
	Sorghum	JJ-938, JJ-1041, JJ-1022, CSH-18	
	Pigeon pea	ICPL-87, ICPL87-119,	
<b>Rabi</b>	Wheat	HW 2004, Lok-1	<ul style="list-style-type: none"> <li>•Dry sowing followed by irrigation -</li> <li>Balanced fertilization</li> <li>•Application of wormi compost @3-4 t/ha</li> <li>•Select short duration varieties for sowing</li> <li>•Seed dressing with Thirum + carbodezim in equal ratio @3g/kg seed -Water harvesting and use collected water as life saving irrigation</li> <li>•Cultivate the field on receiving pre monsoon showers -Need based irrigation by sprinkler</li> <li>• Give irrigation using own source of available water plus tank water (conjunctive use)</li> </ul>
	Chickpea	JG 130, JAKI-92-18	
	Lentil	Lokal	

**Table-4**  
**Distribution of area (ha) under different Land Use of the Surveyed villages**

SI.No.	Village	TGA	Double Cultivation	Net Cropped Area	Gross Cultivation	Cuurent Fallow	Old Fallow	Grass land	Forest,Hills and Plateau	River/ Nala/Hab	Total
1	Ambah	576	427	432	859	0	30	1	0	113	576
2	Atraliya	378	168	327	495	2	31	0	0	18	378
3	BadOgar	661	287	317	604	7	1	35	252	49	661
4	Bagwara	935	817	851	1668	31	1	20	0	32	935
5	Bain	562	492	498	990	13	27	3	0	21	562
6	Baisad	359	298	313	611	22	1	7	0	16	359
7	Bajgaon	554	506	515	1021	0	15	11	0	13	554
8	Balagaon	718	581	620	1201	28	36	2	0	32	718
9	Bankat	NA									
10	Bhadkui	NA									
11	Bhilai	244	212	217	429	9	0	12	0	6	244
12	Bijla	NA									
13	Borda	708	152	508	660	165	1	0	34	0	708
14	Bori	335	295	299	594	6	14	6	0	10	335
15	Borkheda Kalan	1456	123	1274	1397	16	61	49	0	56	1456
16	Borkheda Khurd	511	440	450	890	10	21	6	24	0	511
17	Chaurasa Khedi	385	265	282	547	0	13	13	0	77	385
18	Chhitgaon Moji	1036	950	957	1907	0	20	20	0	39	1036
19	Chichali	437	347	385	732	6	15	8	0	23	437
20	DhanOs	254	204	226	430	0	17	5	0	6	254
21	Dholpur	658	553	565	1118	0	32	13	0	48	658
22	Dobhan	546	374	396	770	103	0	23	0	24	546
23	Ganora	NA									
24	Gilehari	624	314	318	632	15	35	13	201	42	624
25	Gillor	823	670	694	1364	39	22	46	2	20	823



SI.No.	Village	TGA	Double Cultivation	Net Cropped Area	Gross Cultivation	Cuurent Fallow	Old Fallow	Grass land	Forest,Hills and Plateau	River/ Nala/Hab	Total
26	Gopalpur	756	660	690	1350	25	0	10	0	31	756
27	Gorkhpur	962	695	712	1407	0	81	113	25	31	962
28	Gularpura	658	558	594	1152	16	0	30	0	18	658
29	HabibOgar	438	340	352	692	3	13	52	0	18	438
30	Haliakhedi	1049	863	881	1744	42	22	59	0	45	1049
31	Hamidganj	NA									
32	Itarsi	697	427	441	868	51	165	6	0	34	697
33	Itawa Katan	868	591	611	1202	45	146	20	0	46	868
34	Jamonia Kalan	446	391	406	797	1	17	2	0	20	446
35	Jhali	448	310	316	626	0	14	60	47	11	448
36	Jhirnia	381	276	307	583	24	0	20	2	28	381
37	Kharda	805	560	715	1275	0	64	0	0	26	805
38	Kharsaniya Kalan	670	607	622	1229	0	32	5	0	11	670
39	Kumantal	922	810	830	1640	35	5	30	0	22	922
40	Lanchor	NA									
41	Larkui	1230	1016	1038	2054	0	57	52	18	65	1230
42	Mahagoan	856	664	683	1347	36	0	70	27	40	856
43	Mandi	NA									
44	Mariadoh	282	195	216	0	6	20	10	10	20	282
45	Muhai Kalan	964	613	620	1233	9	22	47	232	34	964
46	Ondkot	166	125	126	251	0	21	6	0	13	166
47	Osrullaganj	NA									
48	Owalgoan	116	94	97	191	0	2	17	0	0	116
49	NimOgoan	849	410	802	1212	0	8	11	28	0	849
50	Nimota	1163	804	829	1633	14	2	22	275	21	1163
51	Palasi Kalan	726	616	629	1245	29	3	36	0	29	726
52	Pandagoan	467	375	395	770	0	10	28	6	28	467
53	R.Forest	NA									

SI.No.	Village	TGA	Double Cultivation	Net Cropped Area	Gross Cultivation	Cuurent Fallow	Old Fallow	Grass land	Forest,Hills and Plateau	River/ Nala/Hab	Total
54	Richhariya	576	303	536	839	4	15	2	0	19	576
55	Rujankhedi	490	432	437	869	0	30	4	0	19	490
56	Satdev	NA									
57	Seelkanth	536	404	415	819	13	19	0	89	0	536
58	Semalpani	1054	759	817	1576	0	37	157	0	43	1054
59	Sewania	NA									
60	Shampur	1109	830	975	1805	0	17	54	24	39	1109
61	Sigoan	916	835	861	1696	30	0	2	0	23	916
62	Singpur	225	119	140	259	0	60	23	0	2	225
63	Sohankhedi	NA									
64	Sonthiya	NA									
65	Sukarwas	NA									
67	Suned	474	393	409	802	9	15	19	0	22	474
69	Tigali	NA									
70	Tikamor	1379	847	923	1770	10	14	269	106	57	1379
71	Vasudeo	1036	823	839	1662	81	0	54	0	62	1036
<b>Total</b>		<b>36474</b>	<b>26220</b>	<b>29708</b>	<b>55517</b>	<b>955</b>	<b>1304</b>	<b>1583</b>	<b>1402</b>	<b>1522</b>	<b>36474</b>
<b>% age</b>		<b>100.0</b>	<b>71.9</b>	<b>81.4</b>	<b>152.2</b>	<b>2.6</b>	<b>3.6</b>	<b>4.3</b>	<b>3.8</b>	<b>4.2</b>	<b>100.0</b>

Source: Data collect from concerned village patwari

#### **4. Soil Survey Methodology:**

Detailed soil survey and land use “5D2D3g1 to g5, D4a1 to a4, D4b1 to b4, D4c1 to c3, D4h1 to h9, D4j1 to j8, D4k1 to k3, D4m1, D5j1 to j2 and D6h1 to h2” micro-watersheds of Narmada Catchment was carried out on High resolution satellite data of 1:12,500 scales were used as base material to prepare soil map of the surveyed area. The procedure adopted in carrying out soil survey work with the aid of High resolution satellite data as base, is described below.

Before commencing field work, the true colour imagery of the area was studied to delineate broad landforms which were further subdivided on the basis of photo characteristics like tone, texture, pattern, parceling, drainage etc.

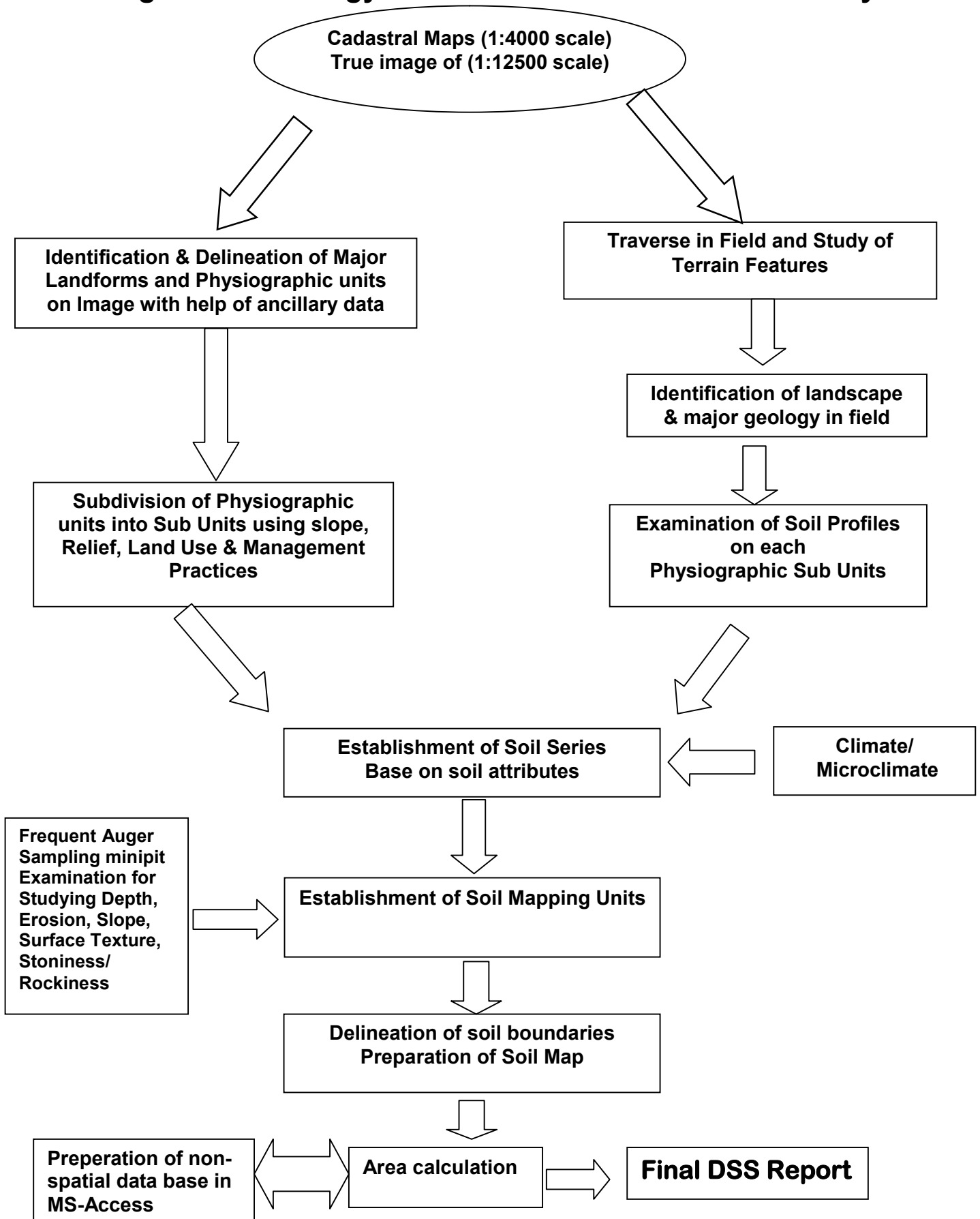
The area was traversed systematically with the help of interpreted imageries to delineate the soil boundaries between types and phases of soil series. The profiles were carefully examined up to the bedrock or up to depth of 1.5 meters for study of morphological characteristics as per guidelines furnished in the soil survey manual of All India Soil & Land Use Survey (1970). The profiles studied were correlated with established soil series to finalize mapping legend. Study and noting of the characteristics such as surface texture, effective depth, slope, erosion status, stoniness, rockiness etc. were done by frequent auguring and traversing of the area.

Combining image characteristic's and field observations soil series and soil mapping units were formed and delineated on the transparencies. Village boundaries were plotted on interpreted transparencies with reference to relevant cadastral maps. Thus the soil map of given watershed is prepared. The area calculation, mapping units and village wise is taken up manually and data obtained is further processed for soil survey interpretation.

During the course of field work, 123 profiles and 181 auger bores were studied in addition to the study of road cuts wherever possible and the soil samples were collected from representative soil profiles for laboratory analysis. Information on present land use, soil conservation practices etc. were collected for most of the mapping units.

The field sheets were further processed and soil map was prepared on 4" = 1 mile scale. The methodology of detailed soil survey is given in fig. 4.

**Fig 4: Methodology & flow chart of Detailed Soil Survey**



## 5. Soils of the Area

### 5.1. General Description of the Soils:

Six soil series were recognized in the survey area based upon the significant differences in their distinguishing characteristics. These are generally moderately fine textured soils under shrubby vegetation, grasses and minor crops. These soils have low water holding capacity and low fertility. Kapsi (KP) soil series are shallow, occurs on strong to moderately sloping hillside slopes, developed over Basalts and have loamy skeletal texture under moderately dense forest vegetation. Chipabad (CH) and Pokharni (PR) soil series are Nearly Level to gentle Sloping developed over Basalts. Khairi (J) soil series are very deep, and Chikhali soil series are deep having gentle to moderate sloping, developed over alluvial plain at Stream banks. The geomorphic settings of the soil series is given in the [table-6](#), to show the relationship between geomorphic location and soils. The differentiating characteristics of all the six soil series mapped are given in [Table-7](#).

**Table-6. Geomorphic Setting of the Soils**

Landscapes	Physiography	Slope	Series
Alluvium	Alluvial plains	Nearly Level to Gentle Sloping	<i>Khairi (KH)</i>
	Stream banks	Gentle slope to Moderate sloping	<i>Chikhali (C)</i>
Basalts	Plateau	Nearly Level to Gentle Sloping	<i>Chipabad( CH)</i>
		Gentle to moderate sloping	<i>Kamtara (KM)</i> <i>Pokharni (PR)</i>
	Sideslope of hills	Strong to moderate steep Sloping	<i>Kapsi (KP)</i>

## 5.2. Soil Series Description:

The description of the six soil series are given below:

### 5.2.1. Chikhali series (C)

These soils are very deep, moderately well drained, developed over Alluvium and occurring on gently sloping to moderately sloping stream banks.

The surface horizon ranges from 11 to 18 cm in thickness with dark yellowish brown colour, sandy loam to clay loam texture and weak, medium, subangular blocky structure. The subsurface horizon ranges from 90 to 99 cm in thickness with dark brown colour, coarse loam to clay loam texture and moderate to strong, fine to coarse, subangular blocky to angular blocky structure.

The following mapping units have been identified and mapped under this series.

<b>Mapping Unit</b>	<b>Description</b>	<b>AREA (ha)</b>
C5dC2	Chikhali, very deep, sandy loam, gently sloping (3-5%), moderate erosion.	73
C5dC3	Chikhali, very deep, sandy loam, gently sloping (3-5%), severe erosion.	518
C5h_C3	Chikhali, very deep, gravelly clay loam, gently sloping (3-5%), severe erosion.	1963
C5h_D3	Chikhali, very deep, gravelly clay loam, moderately sloping (5-10%), severe erosion.	80
C5hC2	Chikhali, very deep, clay loam, gently sloping (3-5%), moderate erosion.	1373
	<b>Total</b>	<b>4007</b>

### 5.2.2. Chipabad series (CH)

These soils are shallow, moderately well drained, developed over Basalt and occurring on gently sloping to moderately sloping Plateau Plains.

The surface horizon ranges from 9 to 11 cm in thickness with dark brown to very dark grayish brown colour, clay texture and moderate, medium, subangular blocky structure. The subsurface horizon ranges from 43 to 48 cm in thickness with very dark grayish brown colour, clay loam to clay texture and moderate, medium, subangular blocky structure.

The following mapping units have been identified and mapped under this series.

<b>Mapping Unit</b>	<b>Description</b>	<b>AREA (ha)</b>
CH4rB(A)1	Chipabad, deep, clay, very gently sloping (1-3%) with terraced land, none to slight erosion.	35
CH4rB2	Chipabad, deep, clay, very gently sloping (1-3%), moderate erosion.	1192
CH4rC2	Chipabad, deep, clay, gently sloping (3-5%), moderate erosion.	654
CH4rC3	Chipabad, deep, clay, gently sloping (3-5%), severe erosion.	67
	<b>Total</b>	<b>1948</b>

### **5.2.3. Kamtada series (KM)**

These soils are shallow, moderately well drained, developed over Basalt and occurring on gently sloping to moderately sloping Plateau Plains.

The surface horizon ranges from 11 to 21 cm in thickness with brown to dark brown colour, gravelly clay to clay loam texture and moderate, medium, subangular blocky structure.

The following mapping units have been identified and mapped under this series.

<b>Mapping Unit</b>	<b>Description</b>	<b>AREA (ha)</b>
KM2h_C2	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), moderate erosion.	360
KM2h_C2S	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), moderate erosion, slightly stony.	173
KM2h_C2SF	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), moderate erosion, moderately stony, Forest.	361
KM2h_C3S	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), severe erosion, slightly stony, forest.	196
KM2h_C3SF	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), severe erosion, slightly stony, forest.	1589
KM2h_D3SF	Kamtada, shallow, gravelly clay loam, moderately sloping (5-10%), severe erosion, slightly stony, forest.	396
	<b>Total</b>	<b>3075</b>

#### **5.2.4. Kapsi series (KP)**

These soils are shallow, well drained, developed over Basalt and occurring on strongly sloping to moderately steep Hills side slopes.

The surface horizon ranges from 11 to 23 cm in thickness with reddish brown to dark reddish brown colour, gravelly sandy loam to gravelly clay loam texture and moderate, medium, subangular blocky structure.

The following mapping units have been identified and mapped under this series.

<b>Mapping Unit</b>	<b>Description</b>	<b>AREA (ha)</b>
KP2d_E3SRF	Kapsi, shallow, gravelly sandy loam, strongly sloping (10-15%), severe erosion, slightly stony and slightly rocky, forest.	152
KP2k_E3SRF	Kapsi, shallow, gravelly sandy clay loam, strongly sloping (10-15%), severe erosion, slightly stony and slightly rocky, forest.	326
KP2h_E3SRF	Kapsi, shallow, gravelly clay loam, strongly sloping (10-15%), severe erosion, slightly stony and slightly rocky, forest.	271
KP2h_F3SRF	Kapsi, shallow, gravelly clay loam, moderately steep (15-25%), severe erosion, slightly stony and slightly rocky, forest.	702
	<b>Total</b>	<b>1451</b>

#### **5.2.5. Khairi series (KH)**

These soils are very deep, poorly drained, developed over Alluvium and occurring on very gently sloping terraced land to gently sloping alluvial plains.

The surface horizon ranges from 11 to 14 cm in thickness with very dark grayish brown colour, clay texture and moderate, medium, subangular blocky structure. The subsurface horizon ranges from 90 to 101 cm in thickness with dark brown to very dark grayish brown colour, clay texture and moderate to strong, medium, subangular blocky to angular blocky structure.

The following mapping units have been identified and mapped under this series.



<b>Mapping Unit</b>	<b>Description</b>	<b>AREA (ha)</b>
KH5rB(A)1	Khairi, very deep, clay, very gently sloping (1-3%) with terraced land, none to slight erosion.	599
KH5rB2	Khairi, very deep, clay, very gently sloping (1-3%), moderate erosion.	12111
KH5rC2	Khairi, very deep, clay, gently sloping (3-5%), moderate erosion.	6759
KH5rC3	Khairi, very deep, clay, gently sloping (3-5%), severe erosion.	1852
	<b>Total</b>	<b>21321</b>

### **5.2.6. Pokharni series (PR)**

These soils are moderately deep, poorly drained, developed over Basalt and occurring on very gently sloping to gently sloping Plateau Plains..

The surface horizon ranges from 9 to 11 cm in thickness with dark brown to very dark grayish brown colour, clay loam to clay texture and moderate, medium, subangular blocky structure. The subsurface horizon ranges from 22 to 27 cm in thickness with dark brown to very dark grayish brown colour, clay texture and moderate, medium, subangular blocky structure.

The following mapping units have been identified and mapped under this series.

<b>Mapping Unit</b>	<b>Description</b>	<b>AREA (ha)</b>
PR3hB2	Pokharni, moderately deep, clay loam, very gently sloping (1-3%), moderate erosion.	41
PR3hC2	Pokharni, moderately deep, clay loam, gently sloping (3-5%), moderate erosion.	249
PR3rB2	Pokharni, moderately deep, clay, very gently sloping (1-3%), moderate erosion.	777
PR3rC2	Pokharni, moderately deep, clay, gently sloping (3-5%), moderate erosion.	885
PR3rC3	Pokharni, moderately deep, clay, gently sloping (3-5%), severe erosion.	20
	<b>Total</b>	<b>1972</b>

### **5.3. Differentiating Characteristics of the Soil Series:**

The differentiating characteristics of the different soil series specifying their parent material, physiographic situation, soil depth, colour, texture, structure, rock fragments and important features are furnished in **Table -7**.

**Table: 7– Differentiating characteristics of the soil series.**

Series	Parent Material	Physiography	Slope (%)	Solum Thickness	Colour		Texture		Structure		Permeability	Drainage	AREA
					Surface	Subsurface	Surface	Subsurface	Surface	Subsurface			
Chikhali (C)	Alluvium	Stream banks	3 - 10	greater than 100 cms	dark yellowish brown	dark brown	sandy loam to clay loam	loam to clay loam	weak, medium, subangular blocky	moderate, fine to coarse, subangular blocky to angular blocky	moderate to rapid	Moderately well	4007
Chipabad (CH)	Basalt	Plateau Plains	1 - 5	51 to 59 cms	dark brown to very dark grayish brown	very dark grayish brown	clay	clay loam to clay	moderate, medium, subangular blocky	moderate, medium, subangular blocky	slow	Poorly	1948
Kamtada (KM)	Basalt	Plateau Plains	3 - 10	11to 21 cms	brown to dark brown	dark brown	clay loam	clay loam to clay	moderate, medium, subangular blocky	moderate, medium, subangular blocky	rapid	Moderately well	3075
Kapsi (KP)	Basalt	Hills side slopes	10 - 25	11 to 23 cms	reddish brown to dark reddish brown	-	gravelly sandy loam to gravelly clay loam	-	moderate, medium, subangular blocky		rapid	Well	1451
Khairi (KH)	Alluvium	Alluvial plains	1 - 5	greater than 100 cms	very dark grayish brown	dark brown to very dark grayish brown	clay	clay	moderate, medium, subangular blocky	moderate, medium, subangular blocky to angular blocky	slow	Poorly	21321

Series	Parent Material	Physiography	Slope (%)	Solum Thickness	Colour		Texture		Structure		Permeability	Drainage	AREA
					Surface	Subsurface	Surface	Subsurface	Surface	Subsurface			
Pokharni (PR)	Basalt	Plateau Plains	1 - 5	31 to 38 cms	dark brown to very dark grayish brown	dark brown to very dark grayish brown	clay loam to clay	clay	moderate, medium, subangular blocky	moderate, medium, subangular blocky	slow	Poorly	1972

#### **5.4. Distribution of area under different soil series and their phases:**

The detailed distribution of area under different soil series and their phases is shown in table -8 (a) & table -8 (b).

Out of the total surveyed area of 35,005 ha about 72.4 % (25,328 ha) is occupied by very deep soils, 5.6 % (1,948 ha) is occupied by deep soils and 18.5 % (6,498 ha) area under shallow to moderately deep soils.

An area of 4.1 % (1,451 ha) of total reported area occurs on strong to moderate steep sloping landforms. About 1.4 % (476 ha) occurs on moderate slope and about 48.8 % (17,092 ha) is under gentle slopes. An area of 1.8 % (634 ha) is covered by terraced lands and 40.3 % (14,121 ha) area have Very gentle slope.

An area of 71.4 % (25,008 ha) of total area suffers from moderate erosion hazards and a large area of 23.2 % (8,132 ha) area suffers from severe erosion which needs immediate attention for soil and water conservation measures.

**TABLE No.-8 (a)**

**Series wise distribution of area under different classes of depth, slope and erosion**

(Area in ha)

SERIES	Area (ha)	% Area	Depth				Slope						erosion		
			d2	d3	d4	d5	B(A)	B	C	D	E	F	e1	e2	e3
Chikhali	4007	11.4	-	-	-	4007	-	-	3927	80	-	-	-	1446	2561
Chipabad	1948	5.6	-	-	1948	-	35	1192	721	-	-	-	35	1846	67
Kamtada	3075	8.8	3075	-	-	-	-	-	2679	396	-	-	-	894	2181
Kapsi	1451	4.1	1451	-	-	-	-	-	-	-	749	702	-	-	1451
Khairi	21321	60.9	-	-	-	21321	599	12111	8611	-	-	-	599	18870	1852
Pokharni	1972	5.6	-	1972	-	-	-	818	1154	-	-	-	-	1952	20
Misc	1231	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>T.Area</b>	<b>35005</b>	<b>100</b>	<b>4526</b>	<b>1972</b>	<b>1948</b>	<b>25328</b>	<b>634</b>	<b>14121</b>	<b>17092</b>	<b>476</b>	<b>749</b>	<b>702</b>	<b>634</b>	<b>25008</b>	<b>8132</b>
<b>% age</b>	<b>100.0</b>		<b>12.9</b>	<b>5.6</b>	<b>5.6</b>	<b>72.4</b>	<b>1.8</b>	<b>40.3</b>	<b>48.8</b>	<b>1.4</b>	<b>2.1</b>	<b>2.0</b>	<b>1.8</b>	<b>71.4</b>	<b>23.2</b>

**Table No. -8 (b)**  
**Micro-watershed wise distribution of area under different classes of depth, slope and erosion**  
(Area in ha)

M/Wsheds	Total area	% age	Misc	Depth				Slope						erosion		
				d2	d3	d4	d5	B(A)	B	C	D	E	F	e1	e2	e3
5D2D3g1	758	2.17	2	-	-	212	544	-	355	401	-	-	-	-	645	111
5D2D3g2	718	2.06	12	-	-	131	575	4	371	331	-	-	-	4	613	89
5D2D3g3	740	2.12	8	-	136	482	114	27	387	318	-	-	-	27	659	46
5D2D3g4	775	2.22	23	-	51	157	544	9	484	259	-	-	-	9	701	42
5D2D3g5	669	1.92	-	-	332	226	111	-	438	231	-	-	-	-	602	67
5D2D4a1	578	1.66	60	-	-	-	518	29	51	438	-	-	-	29	307	182
5D2D4a2	509	1.46	-	-	-	-	509	-	281	228	-	-	-	-	452	57
5D2D4a3	1186	3.40	53	-	-	-	1133	-	364	769	-	-	-	-	920	213
5D2D4a4	873	2.50	-	-	18	31	824	149	298	426	-	-	-	149	566	158
5D2D4b1	1146	3.29	6	-	229	17	894	177	494	469	-	-	-	177	848	115
5D2D4b2	933	2.68	3	-	-	38	892	38	449	443	-	-	-	38	821	71
5D2D4b3	872	2.50	12	-	91	3	766	-	332	528	-	-	-	-	745	115
5D2D4b4	681	1.95	-	326	68	78	209	-	127	228	-	326	-	-	320	361
5D2D4c1	715	2.05	55	-	-	-	660	71	180	409	-	-	-	71	414	175
5D2D4c2	1231	3.53	35	-	-	-	1196	-	239	957	-	-	-	-	680	516
5D2D4c3	854	2.45	141	-	-	5	708	-	63	650	-	-	-	-	523	190
5D2D4h1	984	2.82	138	-	-	-	846	35	40	771	-	-	-	35	454	357
5D2D4h2	518	1.49	165	-	-	-	353	30	94	229	-	-	-	30	141	182
5D2D4h3	1016	2.91	3	-	-	-	1013	32	304	677	-	-	-	32	807	174
5D2D4h4	1026	2.94	13	-	-	-	1013	-	706	307	-	-	-	-	974	39
5D2D4h5	877	2.52	-	-	-	-	877	33	644	200	-	-	-	33	844	-
5D2D4h6	660	1.89	24	-	-	-	636	-	328	308	-	-	-	-	539	97
5D2D4h7	832	2.39	39	-	-	-	793	-	517	276	-	-	-	-	739	54
5D2D4h8	619	1.78	9	-	-	-	610	-	387	223	-	-	-	-	610	-

M/Wsheds	Total area	% age	Misc	Depth				Slope						erosion		
				d2	d3	d4	d5	B(A)	B	C	D	E	F	e1	e2	e3
5D2D4h9	1135	3.26	17	-	-	-	1118	-	857	261	-	-	-	-	1118	-
5D2D4j1	1430	4.10	83	-	-	-	1347	-	475	792	80	-	-	-	773	574
5D2D4j2	497	1.43	4	-	-	-	493	-	284	209	-	-	-	-	438	55
5D2D4j3	924	2.65	18	-	-	-	906	-	654	252	-	-	-	-	804	102
5D2D4j4	593	1.70	5	-	-	-	588	-	372	216	-	-	-	-	565	23
5D2D4j5	868	2.49	3	169	51	97	548	-	511	354	-	-	-	-	666	199
5D2D4j6	637	1.83	45	23	58	49	462	-	395	197	-	-	-	-	550	42
5D2D4j7	288	0.83	39	-	-	-	249	-	108	141	-	-	-	-	189	60
5D2D4j8	431	1.24	29	-	-	-	402	-	253	149	-	-	-	-	342	60
5D2D4k1	239	0.69	34	-	-	-	205	-	24	181	-	-	-	-	118	87
5D2D4k2	1201	3.44	9	111	54	200	827	-	629	509	-	54	-	-	970	222
5D2D4k3	1063	3.05	38	112	35	27	851	-	406	561	-	58	-	-	879	146
5D2D4m1	1209	3.47	62	588	169	151	239	-	438	583	99	11	16	-	696	451
5D2D5j1	1174	3.37	23	134	218	44	755	-	585	566	-	-	-	-	926	225
5D2D5j2	602	1.73	-	483	119	-	-	-	62	325	63	-	152	-	232	370
5D2D6h1	1418	91.95	21	1252	145	-	-	-	53	736	154	79	375	-	277	1120
5D2D6h2	1526	0.264	-	1328	198	-	-	-	82	984	80	221	159	-	541	985
<b>Total</b>	<b>35005</b>	<b>184.2</b>	<b>1231</b>	<b>4526</b>	<b>1972</b>	<b>1948</b>	<b>25328</b>	<b>634</b>	<b>14121</b>	<b>17092</b>	<b>476</b>	<b>749</b>	<b>702</b>	<b>634</b>	<b>25008</b>	<b>8132</b>
<b>% age</b>	<b>100</b>	<b>0.53</b>	<b>3.52</b>	<b>12.93</b>	<b>5.63</b>	<b>5.56</b>	<b>72.36</b>	<b>1.81</b>	<b>40.34</b>	<b>48.83</b>	<b>1.36</b>	<b>2.14</b>	<b>2.01</b>	<b>1.81</b>	<b>71.44</b>	<b>23.23</b>



## **6. SOIL FORMATION AND CLASSIFICATION**

### **6.1. Soil formation**

Soil formation is regarded as the gradual transformation in parent rock of soil by physical, chemical and biological weathering. The soil formation is a process of two consecutive but overlapping stages i.e. weathering of rocks into regolith followed by development of soil from regolith by pedogenic factors and processes. The climate is the most significant factor which controls the type and rate of soil formation. Besides climate, vegetation, parent material, geomorphic situation and relief/ micro relief as well as anthropogenic factors contributed to the development of soils. Depending on the different hydro geomorphic units, pedogenic processes viz. gains, losses, transformation and translocation are in operation. The dominant soil forming processes such as leaching, eluviation, illuviation, percolation and pedoturbation are observed in this area. The climate of the area is sub-tropical monsoonal type and Basalt is the dominant parent material except in the river stream bank where alluvium has been found.

The soil of Khairi and Chikhali Series has been developed by alluvium on alluvial plain. Khairi soil series has fine texture grayish brown to very dark grayish brown colour are developed over old alluvium.

The soil of Chipabad, Kamtada, Kapsi and Pokharn has been developed under in situ condition Kamtada and Kapsi series are shallow soils and developed over plateaus of Basalt rock while Pokharn and Chipabad soil series are moderately deep and deep respectively developed over basaltic plateau plain and have fine loamy to fine texture.

The soils of Kamtada and Kapsi has not shown any diagnostic horizon are kept under Entisols order where as, soils of Pokharn, Chikhali Series shows the sign of alteration due to eluviations having cambic substance horizon are kept under Inceptisols order.

The soil of Khairi and Chipabad has typical characters like black colour, fine texture wide open crack and slickensides in summer season and hence kept in Vertisol order.

## 6.2. Soil Classification

The soils of the area have been classified as per the comprehensive system (USDA) of soil classification (Soil Taxonomy, 11<sup>th</sup> edition, 2010). The primary objective of Soil classification is to establish hierarchies of classes that permit us to understand the relationship among soils and the factors responsible for their character. The classification system defines various diagnostic surfaces, subsurface horizon, and soil temperature & moisture regimes. These are used as differentia for defining the different hierarchical categories of the system namely Order, Suborder, Great groups, Sub groups, Families & Series. The nomenclature of the classification system is connotative and indicative of the specific categories of soils having similar physico-chemical properties.

Three soil orders have been identified in survey area viz. Entisols, Inceptisols and Vertisols. Soils of Chikhali, Kamtada and Kapsi series have no diagnostic horizon hence they are put under order Entisols.

The change of soil colour and structure and activity of free calcium carbonate ion i.e. its removal from upper to lower horizon gives rise to cambic substance horizon found in soils of Pokharni series. Thus these soils are placed under order Inceptisols.

Soils of Khairi and Chipabad series have cracks of 1-3 cm wide which extend to depth of 35-61cms. Intersecting slickensides, 30% and more clay content are the characteristics of these series to put under order Vertisols.

The placements of these soils under suborder, great groups and subgroup have been made on certain parameters like presence of ochric epipedon; ustic moisture regime, chroma of soils and central concept of great groups.

The soil family has been decided on the basis of particle size class, clay mineralogy and temperature regime accordingly. Detailed soil classification is given in tabular form in table No-9.

Table 9: Classification of Soils as per USDA - Soil Taxonomy Eleventh Edition, 2010

Order	Suborder	Great group	Subgroup	Family	Calc /Non Calc	Series
Entisols	Orthants	Ustorthants	Typic Ustorthants	Clayey shallow, Mixed, Hyperthermic	-	<i>Kamtada</i>
				Clayey shallow, Mixed, Hyperthermic	-	<i>Kapsi</i>
	Fluvents	Ustifluvents	Typic Ustifluvents	Coarse Loamy, Mixed, Hyperthermic Typic Ustifluvents		<i>Chikhali</i>
Inceptisols	Ustepts	Haplustepts	Vertic Haplustepts	Fine, Montmorillonitic, Hyperthermic Vertic Haplustepts	-	<i>Pokharni</i>
Vertisols	Usterts	Haplusterts	Leptic Haplusterts	Fine, Montmorillonitic, Hyperthermic Leptic Haplusterts	calcareous	<i>Chipabad</i>
			Typic Haplusterts	Fine, Montmorillonitic, Hyperthermic Typic Haplusterts	calcareous	<i>Khairi</i>

## **7. Physico-Chemical Properties of soils and Interpretation of Data:**

In order to interpret the soil survey data for various uses, thorough look on the soil inherent characteristics is essential. In view of this, soil samples were collected horizon wise for all the established series in the field itself.

Soil samples of representative Pedons were collected and processed for analysis in the laboratory.

Different physical and chemical analysis namely, mechanical analysis, pH, electrical conductivity, organic matter, cation exchange capacity, exchangeable bases, single value constants etc. are carried out in the laboratory, following the standard analytical procedures as described in Appendix-IV. The salient physical and chemical characteristics of each soil series have been furnished with respect to typifying Pedons of the soil series written in Appendix-II.

Out of six soil series established in survey area two soil series namely ,Khairi and Chikhali had develop from alluvium,.The other soil series namely Chipabad ,Kamtara,Kapsi,Pokharni has been developed over Basaltic Parent materials. The soils of Chipabad , Kamtara, and Pokharni have clay content more than 36 percent and have qualifies for fine texture class, where as Chikhali series have clay contain less than 18 % and qualifies for coarse loamy or loamy textural class of soil family ,the shallow depth soils of and Kapsi series qualifies for loamy textural family. The soils of Khairi, Chipabad. and Pokharni have higher clay content and has expanding type of clay therefore it qualifies for Montmorillonitic clay mineralogy.

In general alluvial soils have pH in little higher side between 8.1 to 8.6, while soils developed from Basaltic parent materials has neutral pH value between 6.5 to 7.1.This justifies the relation between parent materials and soils developed from it. The electrical Conductivity of all the soil series is low and indicate that soil salinity problem does not exist in the survey area .Similarly cation exchange capacity was higher in Basaltic and Alluvial soil, series indicating good fertilizer response to the crops.

Organic carbon content ranges between low to medium amongst different soil series indicates available lower content of available nitrogen in these soils. The exchangeable base content and base saturation is found to be high in survey area indicating high buffering capacity of soils.

Available phosphorus and potassium content in most of the soil series is low. However the available Nitrogen content Kapsi & Kamtara and low in other series.

## **8. Soil Survey Interpretations:**

The inherent soil characteristics and external land features like slope, erosion and environmental factor may limit the safe and productive use of soil for various purposes. Combined information of field and laboratory data would give out the nature and potentiality of each soil for different purposes. Thus valid interpretations of the soil survey data is a must for putting the soil survey data for practical utility.

The following interpretations have been made from the soil survey data.

1. Land capability classification.
2. Soil irrigability classification
3. Land irrigability classification
4. Paddy soil grouping
5. Hydrological soil grouping
6. Soil Suitability for crops

Index to soil Mapping Units (Appendix-I) provides the abstract information of various interpretative groupings of the mapping units.

### **8.1. Land Capability Classification:**

Classification of the soil mapping units into capability classes enables to get a picture of various external and inherent hazards causing soil damage, deterioration or lowering in fertility and its potentiality for production when used. It includes both inherent soil characteristics as well as external limitations.

The groupings are indicated at three levels viz., class, sub class, and units details are as under:

#### **Land Capability Classes:**

There are eight land capability classes from I to VIII ( indicated by Roman Numbers) which indicate the limitations in increasing order implying risk of soil limitations increasing progressively from class I to VIII. Soils of class I to IV are suitable for agriculture and V to VIII is suitable for pasture land, forestry wild life and recreation purposes.

#### **Land Capability Sub classes:**

The kinds of limitations which restrict the soil for their sustained use are indicated at sub class level. They are as under:

- i. Risk of erosion (e)
- ii. Wetness, drainage or overflow (w)
- iii. Root zone limitation (s)
- iv. Climate limitations (c)

## **Land Capability Units:**

The land capability units have similar productive potentialities, limitations or hazards requiring similar conservation treatments and management practices. The capability unit, therefore, is grouping of one or more soils that are more or less alike in suitability to plant growth and response to same kind of soil management. Suffixing Arabic numerals to the sub class letter designates them. The numbers indicates the degree and kind of limitations, and management requirements. The main purpose of grouping soils in capability units is to organize the use and treatment of land for successfully raising the crops, pastures and tree plantation (wood Land) over long period of time without deterioration.

Arabic numerals 1, 2, 3, etc. are suffixed to each sub class to indicate specific management need.

Land capability units recognized in survey area and their distribution, series wise and sub-watershed wise are given in **table -10(a) and 10(b)**. The land capability classification has not been attempted for reserve forest area due to administrative reason. The corresponding land capability units have also been marked against the respective mapping units in the village wise mapping unit list (Appendix-III).

A brief description of the Capability grouping as well as soil and land characteristics with inherent problems and conservation measures for improvement have been furnished in the subsequent paragraphs.

### **A. Land Capability Class II (soils with moderate limitations for cultivation)**

This class contributes 13,937ha 39.8% of the total area and comprises deep to very deep soils of, Chhipabad and Khairi series. It includes there capability sub units as described below.

#### **i) Capability Unit IIs-1: -**

This unit consists of deep to very deep, clay soil Chhipabad and Khairi series. This unit includes terrace land having non to slight erosion hazards. These soils are poorly to imperfectly drained with slow permeability.

Following mapping units are grouped under this capability unit.

**Mapping Units:** - CH4r (A)1 & KH5rB(A)1

**Total area:** - 634 ha

**Inherent Problems:** -

- High shrink swell potential
- Slow permeability
- Poor aeration
- Heavy/fine soil texture
- High draft requirements for tillage operation.

**Improvable or Correctable problems:** -

- Erosion susceptibility
- Poor soil tilth.

**Recommendations:** -

- Preparation of good seed bed before monsoon
- Deep ploughing.
- Conservation of moisture and rotation of crops
- Application of manures and fertilizers
- Adoption of Agri-Horticulture cropping system.

**ii) Capability unit Iles-1**

This unit includes very gently sloping lands with very deep, very dark grayish brown cracking clay to sandy loam soils of Chhipabad, Chikhali and Khairi series. The soils have high swell shrink potential. These are imperfectly to poorly drained, slow permeability drained soils. The permeability is moderately slow to slow. They have moderate erosion hazards.

**Mapping Units:** CH4rB2 & KH5rB2

*Total Area-13,303 ha*

**Inherent problems:**

- High swell-shrink potential.
- Slow permeability.
- High draft required for tillage operation.
- Unfavorable Soil texture

**Improvable or correctable problems:**

- Erosion susceptibility.
- Poor aeration.

### **Recommendation for improvement:**

- Preparation of good seedbed by deep ploughing.
- Vegetative soil and water conservation measures.
- Graded bunding and strip cropping
- Rotation of crop with improved agronomic practices.
- Application of FYM with chemical fertilizers.
- Adoption of cereal based cropping system.

### **B. Land Capability Class III (soils have severe limitations for cultivation):**

This class contributes 10,811 ha 30.9 % of the total area and comprises moderately deep to very deep soils of, Khairi, Pokharni,, Chikhali and Chipabad series. It includes there capability sub units as described below.

#### **iii) Capability unit: Illes-1**

This unit comprises of gently sloping deep to very deep and clay loam to clay textured soils of Chipabad, Khairi, and Chikhali series. The soils are moderately well drained and have moderately slow to slow permeability. These soils have moderate erosion hazards.

**Mapping Units:** C5hC2, CH4rC2, C5dC2 & KH5rC2

**Total area-8,859 ha**

#### **Inherent problems: -**

- Fine loamy to fine texture.
- High shrink swell potential
- Slow permeability.
- Poor aeration.
- High draft requirement for tillage operation.
- Slope gradient (3-5%)

#### **Improvable or Correctable problems: -**

- Poor soil tilth.
- Water erosion susceptibility.
- Weeds.

#### **Recommendations: -**

- Deep ploughing in summer season.
- Strip cropping as well as contour bunding.
- Adoption of suitable rotation of crops, soil and water management practices.
- Recommended dose of manures and balanced fertilizers.
- Adoption of Agri-Horticulture cropping system for sustainable Agriculture development.



**iv) Capability unit: Illes-2**

This unit comprises very gently sloping, moderately deep clay soils of Pokharni series. These are moderately well drained with moderate permeability and are having moderate erosion hazards.

Following mapping unit grouped under this capability unit.

**Mapping Units:** PR3rB2 & PR3rB2

*Total area-818 ha*

**Inherent problems: -**

- Limited soil depth.
- Moderately high draft requirement tillage.

**Improvable or Correctable problems: -**

- Poor soil tilth.
- Medium soil fertility.
- Moderate soil erosion.

**Recommendations: -**

- Graded bunding and contour cropping.
- Improving soil tilth by using high dose of organic amendment.
- Adoption of suitable rotation of crops, soil and water management practices.
- Recommended dose of manures and balanced fertilizers.

**v) Land Capability unit Illes-3: -**

This unit comprises gently sloping, moderately deep soils of Pokharni series. These are moderately well drained with moderate permeability and have moderate erosion hazards.

Following mapping units grouped under this capability unit.

**Mapping Unit: -** PR3hC2 & PR3rC2,

Total area: - 1,131 ha

**Inherent Problems: -**

- Moderate soil depth.
- Prolong dryness.
- Root zone limitations.

**Improvable or Correctable problems: -**

- Weed problems.
- Low fertility status.
- Low water holding capacity.
- Slightly gravelliness and stoniness.

**Recommendations: -**

- Improved management practices along with application of organic manures.
- Introduction of leguminous crop during rainy season.
- Adoption of proper crop rotation for optimum yield.
- Careful selection of crop
- Picking up stones and gravels.
- Construction of water Harvesting structure

**C. Land Capability Class IV -**

This class contributes 5,033 ha 14.4 % of the total area and comprises Shallow soils of Kamtara, Chipabad, Khairi, and Chikhali series. It includes there capability sub units as described below.

**vi) Land Capability unit IVes-1: -**

This unit comprises gently sloping, moderately deep soils of Chipabad, Khairi, Chikhali and Pokharni series. These are moderately well drained to imperfectly with moderate permeability and have severe erosion hazards.

Following mapping units grouped under this capability unit.

**Mapping Unit: -** CH4rC3, C5h\_C3, C5dC3, PR3rC3 & KH5rC3

Total area: - 4,420 ha

**Inherent Problems: -**

- Severe water erosion.
- Prolong dryness.
- Root zone limitations/heavy/clay texture soil

**Improvable or Correctable problems: -**

- Weed problems.
- Low fertility status.
- Poor drainage / soil permeability.
- Severe water erosion.

**Recommendations: -**

- Improved management practices along with application of organic manures.
- Introduction of leguminous crop during rainy season.
- Adoption of proper crop plugging of gully heads.
- Picking up stones and gravels.
- Graded bunding.
- Restricted grazing.
- Adoption of Agri-Silvipastural system for for sustainable land management..

**vii) Capability unit: IVes-2: -**

This unit comprises gently sloping lands with shallow, dark grayish brown to reddish brown, gravelley clay loam and non calcareous soils of Kamtara series. These soils are moderately well drained. They have moderate erosion hazards.

**Mapping Units:** KM2h\_C2 & KM2h\_C2S

Total Area-533 ha

**Inherent Problems: -**

- Shallow soil depth.
- Low water holding capacity.
- Unfavorable slope gradient (3-5%).
- Prolonged dryness.

**Improvable or Correctable problems: -**

- Susceptible moderate erosion lands.
- Low soil fertility and poor management.
- Poor soil tilth.

**Recommendations: -**

- Contour bunding.
- Water harvesting structure.
- Application of organic manures.
- Provision of drainage for excess runoff.
- Adoption of Agri-Silvipastoral system for sustainable land management.

viii) **Capability unit: IVes-3: -**

This unit comprises gentle sloping lands with moderate, dark grayish brown to reddish brown, gravelley clay loam and non calcareous soils of Chikhali series. These soils are well drained. They have severe erosion hazards.

**Mapping Units:** C5h\_D3

**Total Area-80 ha**

**Inherent Problems: -**

- High shrink-swell potential.
- Slow permeability.
- Poor aeration.
- Moderate sloping lands.

**Improvable or Correctable Problems: -**

- Severe erosion hazards.
- Unfavorable slope

**Recommendation: -**

- Gully plugging and contour bunding.
- Leveling of lands.
- Occasionally cultivation across the slope.
- Raising of pasture and restricted grazing.
- Provision of drainage for excess runoff

**D. Land Capability Class VI –**

This class contributes 196 ha 0.6 % of the total area and comprises Shallow soils of Kamtara series. It includes there capability sub units as described below.

**ix) Land Capability Unit Vles-1: -**

This unit comprises gently sloping, shallow, dark brown to dark yellowish brown gravelly clay loam to gravelly sandy loam textured soil of Kamtara series. This unit having severe erosion hazards.

Following mapping unit grouped under this land capability unit.

**Mapping unit: - KM2h\_C3S**

Total area: - 196 ha

**Inherent Problems: -**

- Root zone limitations.
- Shallow soil depth.
- Prolonged dryness.
- Slope gradient (3-5%).

**Improved or Correctable Problems: -**

- Low fertility status.
- Water erosion susceptibility.

**Recommendations: -**

- Adopted shallow rooted of short duration crops.
- Deep ploughing in summer.
- Rotation of crops.
- Picking up stones & gravels.

**Table No. 10 (a) Series Wise Distribution of Area in ha under Different Land Capability Units in Narmada Catchments:**

<b>SERIES</b>	<b>Total area (ha)</b>	<b>Misc</b>	<b>Forest</b>	<b>IIs1</b>	<b>IIs1</b>	<b>IIIs1</b>	<b>IIIs2</b>	<b>IIIs3</b>	<b>IVes1</b>	<b>IVes2</b>	<b>IVes3</b>	<b>Vies1</b>
Chikhali	4007	-	-	-	-	1446	-	-	2481	-	80	-
Chipabad	1948	-	-	35	1192	654	-	-	67	-	-	-
Kamtada	3075	-	2346	-	-	-	-	-	-	533	-	196
Kapsi	1451	-	1451	-	-	-	-	-	-	-	-	-
Khairi	21321	-	-	599	12111	6759	-	-	1852	-	-	-
Pokharni	1972	-	-	-	-	-	818	1134	20	-	-	-
Misc	1231	1231	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>35005</b>	<b>1231</b>	<b>3797</b>	<b>634</b>	<b>13303</b>	<b>8859</b>	<b>818</b>	<b>1134</b>	<b>4420</b>	<b>533</b>	<b>80</b>	<b>196</b>
<b>% age</b>	<b>100</b>	<b>3.5</b>	<b>10.8</b>	<b>1.8</b>	<b>38.0</b>	<b>25.3</b>	<b>2.3</b>	<b>3.2</b>	<b>12.6</b>	<b>1.5</b>	<b>0.2</b>	<b>0.6</b>

**Table No. 10 (b) Micro-watershed wise Distribution of Area in ha under Different Land Capability Units in Narmada Catchments**

MICROWATERSHED	Total area	Misc	Forest	IIs1	Iles1	IIIs1	IIIs2	IIIs3	IVes1	IVes2	Vles1
5D2D3g1	758	2	-	-	355	290	-	-	111	-	-
5D2D3g2	718	12	-	4	371	242	-	-	89	-	-
5D2D3g3	740	8	-	27	329	194	-	136	46	-	-
5D2D3g4	775	23	-	9	484	166	-	51	42	-	-
5D2D3g5	669	-	-	-	259	11	-	332	67	-	-
5D2D4a1	578	60	-	29	51	256	-	-	182	-	-
5D2D4a2	509	-	-	-	281	171	-	-	57	-	-
5D2D4a3	1186	53	-	-	364	556	-	-	213	-	-
5D2D4a4	873	-	-	149	298	250	-	18	158	-	-
5D2D4b1	1146	6	-	177	429	190	-	229	115	-	-
5D2D4b2	933	3	-	38	449	372	-	-	71	-	-
5D2D4b3	872	12	-	-	332	342	-	71	115	-	-
5D2D4b4	681	-	326	-	113	139	-	68	35	-	-
5D2D4c1	715	55	-	71	180	234	-	-	175	-	-
5D2D4c2	1231	35	-	-	239	441	-	-	516	-	-
5D2D4c3	854	141	-	-	63	460	-	-	190	-	-
5D2D4h1	984	138	-	35	40	414	-	-	357	-	-
5D2D4h2	518	165	-	30	94	47	-	-	182	-	-
5D2D4h3	1016	3	-	32	304	503	-	-	174	-	-
5D2D4h4	1026	13	-	-	706	268	-	-	39	-	-
5D2D4h5	877	-	-	33	644	200	-	-	-	-	-
5D2D4h6	660	24	-	-	328	211	-	-	97	-	-
5D2D4h7	832	39	-	-	517	222	-	-	54	-	-
5D2D4h8	619	9	-	-	387	223	-	-	-	-	-
5D2D4h9	1135	17	-	-	857	261	-	-	-	-	-
5D2D4j1	1430	83	-	-	475	298	-	-	574	-	-
5D2D4j2	497	4	-	-	284	154	-	-	55	-	-
5D2D4j3	924	18	-	-	654	150	-	-	102	-	-
5D2D4j4	593	5	-	-	372	193	-	-	23	-	-
5D2D4j5	868	3	91	-	508	42	3	48	95	65	13
5D2D4j6	637	45	-	-	373	118	-	58	20	1	22

MICROWATERSHED	Total area	Misc	Forest	Ils1	Iles1	Illes1	Illes2	Illes3	IVes1	IVes2	Vles1
5D2D4j7	288	39	-	-	108	81	-	-	60	-	-
5D2D4j8	431	29	-	-	253	89	-	-	60	-	-
5D2D4k1	239	34	-	-	24	94	-	-	87	-	-
5D2D4k2	1201	9	54	-	623	278	6	48	126	15	42
5D2D4k3	1063	38	58	-	395	396	-	35	87	53	1
5D2D4m1	1209	62	542	-	342	41	-	169	7	46	-
5D2D5j1	1174	23	93	-	418	262	8	210	119	28	13
5D2D5j2	602	-	327	-	-	-	16	103	-	87	69
5D2D6h1	1418	21	1225	-	-	-	8	137	-	27	-
5D2D6h2	1526	-	1081	-	-	-	-	198	-	211	36
<b>Total</b>	<b>35005</b>	<b>1231</b>	<b>3797</b>	<b>634</b>	<b>13303</b>	<b>8859</b>	<b>41</b>	<b>1911</b>	<b>4500</b>	<b>533</b>	<b>196</b>
<b>% age</b>	<b>100</b>	<b>3.5</b>	<b>10.8</b>	<b>1.8</b>	<b>38.0</b>	<b>25.3</b>	<b>0.1</b>	<b>5.5</b>	<b>12.9</b>	<b>1.5</b>	<b>0.6</b>

## **8.2. Irrigability Classes:**

These are special interpretation of soils and land for irrigation. The soil irrigability classes are defined in term of soil properties that express their degree of limitation for development and their requirement for irrigation management. The criteria are based on moisture holding capacity, effective root depth and water intake characteristics. Similarly, attention is given to four factors in classifying land for irrigation, namely cost of land development, the drainability of the land and predicted effect of irrigation water as to the soil salinity and alkalinity status of the soils.

### **3.2.1. Soil Irrigability Classes:**

Five classes of soil irrigability defined in Soil Survey Manual of All India Soil & Land Use Survey (1970) are as below.

- Class – A : None to slight soil limitations for sustained use under irrigation.
- Class – B : Moderate soil limitation for sustained use under irrigation.
- Class – C : Severe soil limitation for sustained use under irrigation.
- Class – D : Very severe soil limitation for sustained use under irrigation.
- Class – E : Not suitable for irrigation (Non irrigable soil class).

Placement of soil series under different soil irrigability classes is discussed below:

#### **Soil Irrigability Class-B:**

Soils having moderate limitations for sustained use under irrigation are grouped into this class. These are very deep soils. These soils are moderately well drained with slow permeability. The water holding capacity of these soils is high.

#### **Soil Irrigability Class-C:**

Soils having severe limitations for sustained use under irrigation are grouped into this class. These are very deep, fine textured soils. These soils are moderately well drained and have moderately slow permeability.



### Soil Irrigability Class-D:

Soils with very severe limitations for sustained use under irrigation are grouped under this class. These are shallow soils. These soils are well drained and have moderately rapid permeability. These soils have moderate to severe erosion.

Soil irrigability classification (Table)

Class A	Class B	Class C	Class D
-	Chikhali	Pokharni	Kamtada
-	Chipabad	-	-
-	Khairi	-	-

### 3.2.2. Land Irrigability Classes:

The suitability of land for irrigation depends on physical and socio-economic factors in addition to the soil irrigability class, quality and quantity of water, drainage requirements and other conditions. The following land irrigability classes have been established.

Class –1 : Lands that have few limitations for sustained use under irrigation.

Class –2: Lands that have moderate limitations for sustained use under irrigation.

Class –3: Lands that have severe limitations for sustained use under irrigation.

Class –4: Lands that have marginal for sustained use under irrigation.

Class –5: Lands that are temporarily classed as not suitable for sustained use under irrigation.

Class –6: Lands not suitable for sustained use under irrigation.

## **Land Irrigability Sub Classes:**

Land irrigability sub classes are groups of land irrigability units that have the same kind of dominant limitations for sustained use under irrigation. When lands are placed in any class higher than 1 the limitations are indicated by appending the letter s, t, d, number of show whether the limitations are in the soil topography or drainage respectively. Lands with more than one limitation are also indicated such as 2st.

Following grouping have been made for the land irrigability classes.

### **Land Irrigability class- 2:**

They comprise lands that have very gentle slope and grouped under soil irrigability class A and B. Land leveling and surface drainage are the important management needs of the land.

### **Land Irrigability class -3:**

Lands of this class have severe limitations for either soil or topography for their sustained use under irrigation. They comprise the mapping units included under soil irrigability class A, B, and C that have slope of 1 to 5%. Land leveling and drainage are important management needs of these lands.

### **Land Irrigability class -4:**

Lands of this class have very severe limitations of shallow depth, severe erosion etc. The mapping units included under soil irrigability class C and D are grouped in this class. The slope of this land ranges from 1-5 %. Graded bunding and contour bunding are necessary to manage these lands properly.

### **Land Irrigability class -6:**

Lands unsuitable for sustained use under irrigation on account of slope, gravelliness, stoniness, and shallow depth are covered under this group and are better suited for permanent vegetation of economic species.

### Land irrigability classification

2st	3st	6st
CH4rB(A)1	C5dC2	KM2h_C2
KH5rB(A)1	C5hC2	KM2h_C3S
	CH4rB2	KM2h_C2S
	CH4rC2	
	CH4rC3	
	KH5rB2	
	KH5rC2	
	C5h_C3	
	PR3hC2	
	C5dC3	
	C5h_D3	
	PR3rC3	
	PR3rC2	
	PR3rB2	
	PR3hB2	
	KH5rC3	

### 8.3. Soil Suitability for Paddy:

Rainfed paddy is sown in local depressions. Paddy soil group is the grouping according to their suitability for growing paddy. Soil characteristics used in establishing these groups include soil depth, texture, puddling quality, permeability, salinity or alkalinity and slope. An attempt to group a set of different mapping units into defined paddy groups has been made and results are shown in the table below; four groups viz. (1) very Good, (2) Good (3) Fair, (4) Poor to unsuitable are recognized.

The criteria used for this grouping are shown below:

#### Paddy Soil Grouping

Suitability Grouping				
Particulars	Very good (1)	Good (2)	Fair (3)	Poor to unsuitable (4)
<b>Texture</b>	Fine	Fine to moderately fine	Medium to moderately coarse	Coarse
<b>Depth</b>	Deep to very	Deep to very	Moderately deep	Shallow

	deep	deep	to deep	
<b>Salinity (dsm-1)</b>	Less than 4	4-8	8-16	More than16
<b>Exchangeable Na+ percent</b>	Less than 15	Less than 15	Less than 15	More than15
<b>Pudding quality</b>	Good	Good	Fair	Poor
<b>Permeability</b>	Very slow to slow	Very slow to slow	Moderately slow to slow	Moderate to rapid
<b>Slope</b>	0-1%	1-3%	3-5%	More than 5 %

**Group- 1 (Very Good):** Deep to very deep soils with fine textures, nearly level land situated in depression. The soils are well protected from erosion. The soils are neither saline nor alkaline.

**Group-2 (Good):** Very gently sloping lands with deep to very deep soils with fine to moderately fine textures. The soils are well protected from erosion by bund. They are neither saline nor alkaline.

**Group-3 (Fair):** Moderately deep to very deep, fine to moderately coarse textured on very gently sloping lands. These are moderately to severely eroded.

**Group- 4 (Poor to unsuitable):** Soils of this group are unsuited for paddy grouping. This group consists of soils of shallow depth with gentle to steep slope and severe erosion. Soil mapping units are interpreted for paddy soil grouping as under:

<b>Group-1 (Very good)</b>	<b>Group-2 (Good)</b>	<b>Group-3 (Fair)</b>	<b>Group-4 (Poor to unsuitable)</b>
KH5rB(A)1	KH5rB2	C5hC2	C5dC2
CH4rB(A)1	CH4rB2	CH4rC2	C5dC3
		KH5rC2	C5h_C3
			C5h_D3
			CH4rC3
			KH5rC3
			KM2h_C2
			KM2h_C2S
			KM2h_C3S
			PR3hB2
			PR3hC2
			PR3rB2

			PR3rC2
			PR3rC3

#### 8.4. Hydrological Soil Groupings:

These groups are suggestive of runoff from rainfall. They are useful for hydrological soil studies, particularly in watershed management programme. An attempt to classify the soils into hydrological soil groups has been made on the basis of profile studies of different soil series and important soil characteristics like effective depth, permeability and soil structure etc. The results are given in Appendix-I.

Hydrological groups have been defined as under:

##### A- (Low runoff potential):

Soils are deep, well to excessively drained, sands and gravels and have higher infiltration rates. None of the soil series falls under this group.

##### B- (Moderately low runoff potential):

Moderately deep to deep, moderately well to well drained, fine to moderately coarse textured soils with moderate infiltration rate.

##### C- (Moderately high runoff potential):

Moderately deep to deep moderately coarse textured soils having low infiltration rates. Maharajpur, Chikhali & Uda soil series falls under this group.

##### D- (High runoff potential):

Clayey soils with high swell shrink potential, high water table, clay pan and shallow soils covering nearly impervious material and having low infiltration rates. Pauri soil series fall under this group.

**Hydrological Grouping of Soil**

<b>B</b>	<b>C</b>	<b>D</b>
Chikhali	Pokharni	Kamtada
-	Chipabad	-
-	Khairi	-

### 8.5. Suitability for other crops:

Soil suitability for important crops of the area under rainfed condition has been attempted on the basis of soil characteristics, slope and drainage condition and runoff potential. Five classes have been designated viz. VG –Very good, G-Good, F-Fair, P-Poor and VP –Very Poor or unsuitable.

**TABLE -11.Relative suitability of the soil series for crops of the area**

Sl.No.	Name of Soil Series and symbol	Paddy		Wheat		Mustard		Millets		Pulses	
		RF	IR	RF	IR	RF	IR	RF	IR	RF	IR
1	Chipabad	G	VG	G	VG	G	VG	G	VG	G	VG
2	Khairi	G	VG	G	VG	G	VG	G	VG	G	VG
3	Pokharni	P	P	P	G	G	VG	G	VG	G	G
4	Chikhali	F	G	G	VG	G	VG	G	G	G	G

**RF- Rainfed**

**G- Good**

**IR- Irrigated**

**F- Fair**

**VG-Very Good**

**VP-very Poor**

**P-Poor**

## 9. SPECIFIC PROBLEMS AND RECOMMENDATIONS

The area under survey has problems of different degree of erosion hazards in combination with erosive slopes and soil depth with or without gravelliness and stoniness.

It is observed that out of total surveyed area 71.4 % (25,008 ha) of total area suffers from moderate erosion hazards and a large area of 23.2 % (8,132 ha) area suffers from severe erosion

The 4.1 % (1,451 ha) of total reported area occurs on strong to moderate steep sloping landforms. About 1.4 % (476 ha) occurs on moderate slope and about 48.8 % (17,092 ha) is under gentle slopes. An area of 1.8 % (634 ha) is covered by terraced lands and 40.3 % (14,121 ha) area have Very gentle slope.

The data presented in Table-12 highlights the specific problems and recommendations. The data may prove to be helpful in selecting the area to be taken for soil conservation measures on priority basis.

**Table-12: Specific problems and Recommendations.**

SI No	Mapping Unit	Area (ha)	Specific Problems	Broad Suggestions
1	CH4rB2 KH5rB2	1192 12111	<ul style="list-style-type: none"> <li>• High shrink swell potential</li> <li>• Slow permeability</li> <li>• Poor aeration</li> <li>• High draft requirements for tillage operation.</li> <li>• Poor soil tilth.</li> <li>• Erosion susceptibility</li> <li>• Nutrients fixation</li> </ul>	<ul style="list-style-type: none"> <li>• Graded bunding and strip cropping.</li> <li>• Preparation of good seed bed before monsoon</li> <li>• Rotation of crops</li> <li>• Recommended doses of manures and balanced fertilizers.</li> <li>• Deep ploughing in summer months.</li> <li>• Adoption of Agri-Horticulture system</li> </ul>
2	C5hC2 CH4rC2 KH5rC2 C5dC2	1373 654 6759 73	<ul style="list-style-type: none"> <li>• High shrink swell potential</li> <li>• Slow permeability</li> <li>• Poor aeration</li> <li>• High draft requirement for tillage operation.</li> <li>• Slope gradient (3-5%)</li> <li>• Poor soil tilth.</li> <li>• Water erosion susceptibility</li> <li>• Weeds</li> </ul>	<ul style="list-style-type: none"> <li>• Strip cropping as well as contour bunding.</li> <li>• Deep ploughing in summer season.</li> <li>• Recommended doses of manures and balanced fertilizers.</li> <li>• Adoption of suitable rotation of crops, soil and water management practices</li> <li>• Land leveling &amp; bunding</li> <li>• Adoption of Agri-Horticulture system.</li> </ul>

SI No	Mapping Unit	Area (ha)	Specific Problems	Broad Suggestions
3.	CH4rB(A)1 KH5rB(A)1	35 599	<ul style="list-style-type: none"> <li>• High shrink swell potential</li> <li>• Slow permeability</li> <li>• Poor aeration</li> <li>• High draft requirements for tillage operation</li> <li>• Erosion susceptibility</li> <li>• Poor soil tilth.</li> </ul>	<ul style="list-style-type: none"> <li>• Preparation of good seed bed before monsoon</li> <li>• Deep ploughing.</li> <li>• Conservation of moisture through vegetative manure and rotation of crops.</li> <li>• Application of manures and fertilizers.</li> <li>• Adoption of Cereal/pulse based cropping system</li> </ul>
4	CH4rC3 KH5rC3 C5h_C3 C5dC3	67 1852 1963 518	<ul style="list-style-type: none"> <li>• High shrink-swell potential.</li> <li>• Slow permeability.</li> <li>• Poor aeration.</li> <li>• Gently sloping lands.</li> <li>• Severe erosion hazards.</li> <li>• Poor soil tilth.</li> </ul>	<ul style="list-style-type: none"> <li>• Gully plugging and contour bunding.</li> <li>• Leveling of lands.</li> <li>• Occasionally cultivation across the slope.</li> <li>• Raising of pasture and restricted grazing.</li> </ul>
5	KM2h_C3S	196	<ul style="list-style-type: none"> <li>• Root zone limitation.</li> <li>• Shallow soil depth.</li> <li>• Prolonged dryness.</li> <li>• Low fertility status.</li> <li>• High slope gradient</li> <li>• Severe erosion hazards.</li> </ul>	<ul style="list-style-type: none"> <li>• Plantation of suitable forest species</li> <li>• Contour trenching across the slope.</li> <li>• Gully plugging.</li> <li>• Plantation after gully plugging.</li> <li>• Protection of existing forest.</li> </ul>
6	KM2h_C2 KM2h_C2S	360 173	<ul style="list-style-type: none"> <li>• Prolong dryness.</li> <li>• Root zone limitations.</li> <li>• Weed problems.</li> <li>• Low fertility status.</li> <li>• Low water holding capacity.</li> <li>• Slightly gravelliness and stoniness</li> <li>• Moderate severe erosion hazards.</li> </ul>	<ul style="list-style-type: none"> <li>• Contour bunding and strip cropping.</li> <li>• Harvesting rain water</li> <li>• Picking up stones &amp; gravel.</li> <li>• Improved management practices along with applications of organic manures.</li> <li>• Introduction of leguminous crop during rainy season.</li> <li>• Gully plugging</li> </ul>
7	C5h_D3	80	<ul style="list-style-type: none"> <li>• High shrink-swell potential.</li> <li>• Moderately slow to slow permeability.</li> <li>• Poor aeration.</li> <li>• Gently sloping lands.</li> <li>• Severe erosion hazards.</li> <li>• Poor soil tilth.</li> </ul>	<ul style="list-style-type: none"> <li>• Gully plugging and contour bunding.</li> <li>• Leveling of lands.</li> <li>• Occasionally cultivation across the slope.</li> <li>• Raising of pasture and restricted grazing.</li> </ul>



<b>SI No</b>	<b>Mapping Unit</b>	<b>Area (ha)</b>	<b>Specific Problems</b>	<b>Broad Suggestions</b>
8	PR3hC2 PR3rC2 PR3hB2 PR3rB2	249 885 41 777	<ul style="list-style-type: none"> <li>• High shrink swell potential</li> <li>• Slow permeability</li> <li>• Poor aeration</li> <li>• High draft requirement for tillage operation.</li> <li>• Slope gradient (3-5%)</li> <li>• Poor soil tilth.</li> <li>• Water erosion susceptibility</li> <li>• Weeds</li> </ul>	<ul style="list-style-type: none"> <li>• Strip cropping as well as contour bunding.</li> <li>• Deep ploughing in summer season.</li> <li>• Recommended doses of manures and balanced fertilizers.</li> <li>• Adoption of suitable rotation of crops, soil and water management practices</li> </ul>

## Guide to Mapping Units

SERIES	Mapping Unit	Description	Total	LCU	SIC	LISC	HSG	PSG	Management
Pokharni	PR3hC2	Pokharni, moderately deep, clay loam, gently sloping (3-5%), moderate erosion.	249	Illes3	C	3st	C	PU	M1
Pokharni	PR3hB2	Pokharni, moderately deep, clay loam, very gently sloping (1-3%), moderate erosion.	41	Illes2	C	3st	C	PU	M1
Pokharni	PR3rB2	Pokharni, moderately deep, clay, very gently sloping (1-3%), moderate erosion.	777	Illes2	C	3st	C	PU	M1
Pokharni	PR3rC2	Pokharni, moderately deep, clay, gently sloping (3-5%), moderate erosion.	885	Illes3	C	3st	C	PU	M1
Pokharni	PR3rC3	Pokharni, moderately deep, clay, gently sloping (3-5%), severe erosion.	20	IVes1	C	3st	C	PU	M1
Khairi	KH5rC2	Khairi, very deep, clay, gently sloping (3-5%), moderate erosion.	6759	Illes1	B	3st	C	F	M2
Khairi	KH5rB2	Khairi, very deep, clay, very gently sloping (1-3%), moderate erosion.	12111	Iles1	B	3st	C	G	M3
Khairi	KH5rB(A)1	Khairi, very deep, clay, very gently sloping (1-3%) with terraced land, none to slight erosion.	599	Ils1	B	2st	C	VG	M3
Khairi	KH5rC3	Khairi, very deep, clay, gently sloping (3-5%), severe erosion.	1852	IVes1	B	3st	C	PU	M1
Kapsi	KP2h_E3SRF	Kapsi, shallow, gravelly clay loam, strongly sloping (10-15%), severe erosion, Slightly stony and Slightly rocky.	271	Forest	-	-	-	-	-
Kapsi	KP2k_E3SRF	Kapsi, shallow, gravelly sandy clay loam, strongly sloping (10-15%), severe erosion, Slightly stony and Slightly rocky.	326	Forest	-	-	-	-	-
Kapsi	KP2d_E3SRF	Kapsi, shallow, gravelly sandy loam, strongly sloping (10-15%), severe erosion, Slightly stony and Slightly rocky.	152	Forest	-	-	-	-	-
Kapsi	KP2h_F3SRF	Kapsi, shallow, gravelly clay loam, moderately steep (15-25%), severe erosion, Slightly stony and Slightly rocky.	702	Forest	-	-	-	-	-
Kamtada	KM2h_C3S	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), severe erosion, Slightly stony.	196	Vles2	D	6st	D	PU	-

<b>SERIES</b>	<b>Mapping Unit</b>	<b>Description</b>	<b>Total</b>	<b>LCU</b>	<b>SIC</b>	<b>LISC</b>	<b>HSG</b>	<b>PSG</b>	<b>Management</b>
<b>Kamtada</b>	<b>KM2h_C2SF</b>	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), moderate erosion, Moderately stony.	361	Forest	-	-	-	-	-
<b>Kamtada</b>	<b>KM2h_C2</b>	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), moderate erosion.	360	IVes2	D	6st	D	PU	M1
<b>Kamtada</b>	<b>KM2h_C3SF</b>	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), severe erosion, Slightly stony.	1589	Forest	-	-	-	-	-
<b>Kamtada</b>	<b>KM2h_D3SF</b>	Kamtada, shallow, gravelly clay loam, moderately sloping (5-10%), severe erosion, Slightly stony.	396	Forest	-	-	-	-	-
<b>Kamtada</b>	<b>KM2h_C2S</b>	Kamtada, shallow, gravelly clay loam, gently sloping (3-5%), moderate erosion, Slightly stony.	173	IVes2	D	6st	D	PU	M1
<b>Chipabad</b>	<b>CH4rC3</b>	Chipabad, deep, clay, gently sloping (3-5%), severe erosion.	67	IVes1	B	3st	D	PU	M1
<b>Chipabad</b>	<b>CH4rB(A)1</b>	Chipabad, deep, clay, very gently sloping (1-3%) with terraced land, none to slight erosion.	35	IIs1	B	2st	C	VG	M3
<b>Chipabad</b>	<b>CH4rC2</b>	Chipabad, deep, clay, gently sloping (3-5%), moderate erosion.	654	Illes1	B	3st	D	F	M2
<b>Chipabad</b>	<b>CH4rB2</b>	Chipabad, deep, clay, very gently sloping (1-3%), moderate erosion.	1192	Iles1	B	3st	D	G	M3
<b>Chikhali</b>	<b>C5dC2</b>	Chikhali, very deep, sandy loam, gently sloping (3-5%), moderate erosion.	73	Illes1	B	3st	B	PU	M1
<b>Chikhali</b>	<b>C5hC2</b>	Chikhali, very deep, clay, gently sloping (3-5%), moderate erosion.	1373	Illes1	B	3st	B	F	M1
<b>Chikhali</b>	<b>C5h_D3</b>	Chikhali, very deep, gravelly clay loam, moderately sloping (5-10%), severe erosion.	80	IVes3	B	3st	B	PU	M1
<b>Chikhali</b>	<b>C5h_C3</b>	Chikhali, very deep, gravelly clay loam, gently sloping (3-5%), severe erosion.	1963	IVes1	B	3st	B	PU	M1
<b>Chikhali</b>	<b>C5dC3</b>	Chikhali, very deep, sandy loam, gently sloping (3-5%), severe erosion.	518	IVes1	B	3st	B	PU	M1
-	<b>River</b>	-	254	-	-	-	-	-	-
-	<b>Tank</b>	-	8	-	-	-	-	-	-
-	<b>Nala</b>	-	431	-	-	-	-	-	-
-	<b>Hab.</b>	-	538	-	-	-	-	-	-

## APPENDIX-IV

### Methods Used in Physico-Chemical Analysis

#### Estimation of Soil Physical Constants

1.	<b>Mechanical analysis</b>	USDA, Method, Piper (1950)
2.	<b>Moisture equivalent</b>	Centrifuge Method (2440rpm for 30 minutes), Piper (1950)
3.	<b>Single value constants</b>	WHC, Sp.Gravity, Bulk density) Keen Reckowski Box,Coults,J.R.H.(1930)

#### Physico-Chemical Analysis

1.	<b>Soil reaction (pH)</b>	By Elico-pH meter, using 1:2 soil water ratio
2.	<b>Electrical Conductivity (EC)</b>	Water ratio measured by Conductivity Bridge using 1:2 soil water ratio
3.	<b>Mechanical Analysis</b>	By Bouyouces Hydrometer Method using Sodium Hexametaphosphate (Calgan) as dispersing agent
4.	<b>Organic Carbon</b>	By Walkley and Black rapid titration method organic carbon is oxidized by Potassium Dichromate solution in presence of conc. Sulphuric acid. The excess Dichromate ion is back titrated and measured. The quantity of Organic matter oxidized is calculated from the amount of Dichromate ions reduced
5.	<b>Calcium Carbonate</b>	By using Calciometer, Acid(HCL) water ratio is 1:3
5.	<b>Exchangeable Cations</b>	<b>Calcium and Magnesium</b> – By Versenate method using 1 N Sodium Chloride as extracting solution. <b>Sodium and Potassium</b> –By Flame photometer using 1N neutral Ammonium Acetate as extracting solution
6.	<b>Cation Exchange Capacity</b>	By ammonium saturation techniques described by Schellonberger and Droibelbis (1930)

## APPENDIX-V

### EXPLANATORY SYMBOLS

Sl. No.	Soil Series	Symbol
1	Chikhali	C
2	Chipabad	CH
3	Kamtada	K
4	Kapsi	KP
5	Khairi	KH
6	Pokharni	P

Sl. No.	Soil Depth	Symbol
1.	Very Shallow soil (<10 cm)	1
2.	Shallow soil (10-25 cm)	2
3.	Moderately deep (25-50 cm)	3
4.	Deep (50-100 cm)	4
5.	Very deep ( > 100 cm )	5

Sl. No.	Textural class	Symbol
1.	Sand	a
2.	Loamy very fine sand	b
3.	Loamy sand	c
4.	Sandy loam	d
5.	Loam	e
6.	Silty loam	f
7.	Silt	g
8.	Clay loam	h
9.	Sandy clay loam	k
10.	Silty clay loam	m
11.	Sandy clay	n
12.	Silty clay	p
13.	Clay	r

Sl. No.	Slope Classes	Symbol
1.	Nearly level (0-1%)	A
2.	Very gentle slope (1-3%)	B
3.	Gentle slope (3-5%)	C
4.	Moderate slope (5-10%)	D
5.	Strong slope (10-15%)	E
6.	Moderate steep slope (15-25%)	F
7.	Steep slope (25-33%)	G
8.	Very steep slope (33-50%)	H
9.	Very very steep slope (50% & above )	I

Sl. No.	Erosion classes	Symbol
1.	None to slight	e1
2.	Moderate	e2
3.	Severe	e3

1.	Gravelliness	15-30% of surface covered G
2.	Stoniness	15-30% Slight of surface covered S
3.	Rockiness	15-30% slight of surface covered R

Sl. No.	Symbol	Present Land Use
1	C1	Single Crop Cultivation
2	C2	Double Crop Cultivation
3	C1t	Single Crop Terraced Cultivation
4	Cx	Occasional Cultivation
5	W1	Waste Land Suitable for Cultivation
6	W2	Waste Land unsuitable for cultivation
7	F1	Forest (
8	F2	Forest (10-20% canopy cover)
9	F3	Forest (20-40% canopy cover)
10	F4	Forest (40-60% canopy cover)
11	F5	Forest (>60% canopy cover)
12	G	Grass Land / Pasture land
13	P	Plantation
14	O	Open Scrub
15	ML	Misc. Land

Sl. No.	Symbol	Management
1	M1	unmanaged(UB)
2	M2	poorly managed(PB)
3	M3	moderately managed(MB)
4	M4	well managed(WB)
5	ML	Misc. Land

## APPENDIX-VI

### Glossary of Technical Terms

**Alluvium:-** Alluvium is a more or less stratified deposit of gravel, sand, silt or clay or other debris by river or any form of running water from higher to lower ground.

**Argillic:-** A mineral soil horizon that is characterized by layer lattice silicate clay. The argillic horizon has a certain minimum thickness depending on the thickness of the solum, a minimum quantity of clay in comparison with an alluvial horizon, and usually has coatings of oriented clays on the surface of poros or peds, or bridging sand grains.

**Angular blocky:-** The block like structure of soil bounded by lanes intersecting at relatively sharp angle.

**Cambic:-** A mineral soil horizon that has texture of loamy very fine sand of finer soils structure rather than rock structure, contain some weatherable mineral material as indicated by mottling or gray colours, stronger chromas or render hues than underlying horizons or the removal of carbonates. The cambic horizon lacks cementation or induration and has too few evidence of illuviation to meet the requirements of the argillic or spodic horizon.

**Calcareous soil:-** Soil containing free calcium carbonate, dispersed in the soil mass.

**Cation exchange capacity: -** Capacity of the soil to hold cations on its colloidal particles by the surface forces. It is usually expressed as milli equivalent per 100 gms.

**Clay:** A soil separate with less than 0.002 mm diameter.

**Classification:-** The assignment of object or units to groups within a system of categories distinguished by their properties.

**Chroma:-**One of the three variables in colour. The relative purity of strength (sometimes called saturation) of the spectral colour. The chroma increases with increasing purity to the dominant wave length of light or decreasing grayness.

**Concretions:-** Hardened, local concretions of certain chemical compounds, as calcium carbonates, iron oxides, manganese oxides, etc in the form of indurate grains or nodules of various sizes, shapes and colour.

**Colluvium:-** A deposit of rock fragments and soil material accumulated at the base of steep slope as a result of gravitational action.

**Lithic contact:-** A boundary between soil and continuous coherent, underlain material, the underlying material must be sufficiently coherent to make hand digging with a spade impracticable. The mineral, must have a hardness of 3 or more (moh. Scale) and gravels size chunks that can be broken out, but do not disperse with 15 hours shaking in water or sodium hexameta-phosphate solution.

**Paralithic contact:-** Similar to lithic contact except that the mineral material below the contact has hardness of less than 3 (moh. Scale). The gravel size chunks that can be broken out hours shaking in water or sodium hexameta-phosphate solution.

**Clay:-** A soil with more than 35% Clay.

**Clay loam:-** A clay loam is a fine textured soils which usually breaks into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and finger it will form a thin "ribbon" which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cone which will bear much handling when kneaded in the hand it does not crumble readily but tends to work into heavy compact mass.

**Coarse fragments:-** Masses of mineral or rock materials greater than 2mm in diameter.

**Coarse textured:-** It includes the sand, loamy sand and sandy loam textural classes.

**Consistence:-** (i) Resistance to deformation of material.

(ii) The degree of cohesion or adhesion of the soil mass or its resistance to deformation or rupture.

**Drainage:** - Rapidly and extent of the removal of water from the soil in relation to additions. As a soil condition it refers to the frequency and duration of period when the soil is free of saturation or partial saturation.

**Epipedon:-** A generalized term employed in taxonomy (U.S. system of soil classification) to express diagnostic surface horizon.

**Entisols:-** Soil without horizon differentiation or when profile development has just begun.

**Fluviatile:-** Geomorphic process connoting development of land form as a result of sedimentation by running water. Floor plain formation, levees, point bar complex, etc are some of the examples of fluvial sedimentation processes.

**Fluvent:** - Entisols that feature recent loamy or clayey alluvial deposit are usually stratified, and have an organic content that decreased irregularly with depth. Fluvent are not saturated with water for periods long enough to limit their use for most of the crops (A suborder in U.S.D.A. soil taxonomy).

**Geomorphic process:-** Covers all those physical and chemical changes which effect a modification of earth's surface form through the process of gradation, degradation, weathering and gravitational transfer, diastrophism, volcanism, and in fall of meteorites and mass wasting.

**Horizon:-** A layer of soil approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical and biological properties such as colour, texture, structure, consistency etc. The five master horizons recognized are O, A, B, C, and R.

**A Horizon:-** Mineral horizons consisting of: (i) horizons of organic matter accumulation formed or forming at or adjacent to the surface (ii) horizons that have lost clay, iron or aluminium with resultant concentration of quality or other resistant mineral of sand or silt size or (iii) Horizons dominated by 1 or 2 above transitional to and underlying B or C.

**Ap Horizon:-** A ploughed surface layer of soil with ploughing or other disturbances.

**C Horizon:-** A horizon generally beneath the solum which is relatively little affected by biological activity and pedogenesis and is lacking properties diagnostic of an A or B horizon. It may not be like the material from which the A and B have formed.



**Hyperthermic:-** A temperature class, recognized for family differentiation in 'Soil Taxonomy'(U.S. system of soil classification) signifying soil temperature more than 220c with difference of more than 50c in mean summer and mean winter temperature at 50 cm depth or more.

**Hue:-** One of the three variable of colour. The dominant spectral colour, that changes with the dominant length of the light.

**Infiltration:** The entry of water into the soil.

**Infiltration rate:** - The maximum rate that a soil, in a given condition at a given time, can rate at which a soil will absorb water impounded on the surface at a shallower depth. When adequate precautions are taken regarding border effects and defined as a volume of water passing into the soils per unit of area per unit of time, it has the dimensions of velocity.

**Irrigation:-** Artificial application of water to the soil for supplying water to crops.

**Inceptisols:-** Soils in which horizon differentiation and profile development has just begun.

**Impeded drainage:-** Condition in which downward movement of gravitational water is hindered.

**Lime concretions;-** An aggregate cemented by precipitation of  $\text{CaCO}_3$ .

**Levee:-** Levee is a low wide ridge location immediately adjacent to the river channel. They are highest near the river and slopes gradually away from it.

**Landscape:-** It refers to the natural relief and structural features such as hills, plateaus, valleys bodies water etc. which distinguish one from another part of the earth's surface.

**Medium textured:-** Intermediate between fine textured and coarse textured soils include very fine sandy loam, silt loam and silt texture classes.

**Mineral soils:-** A soil whose properties are dominated by the mineral matter, usually containing less than 20% organic carbon or only a thin surface organic layer.( less than 30 cm thick).

**Mottling:-** Spots or blotches of different colour or shades of colour interspersed with the dominant colour.

**Parent material:-** The unconsolidated or alternated, more or less chemically weathered mineral or organic matter from which the soil profile is developed by Pedogenic processes. Common bed rocks and other materials furnishing parent material for the soils in India are basalt, granite, sandstone, shales, limestone, phyllities, alluvium and lacustrine deposits.

**Permeability:-** It is the property of a porous medium itself that relates to the ease with which gases, liquids or other substances can pass through it.

**Pediments:-** It refers to transitional lands between hills and plains in arid and semi arid climate. They have abrupt boundaries.

**Physiography:-** Physiography refers to the study of the physical feature of the earth, their formation and their relation to one another. It, therefore, involves study of the factors and processes responsible for evolution of landforms.