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Classification Of Soils And Land Irrigability For Paliganj Distributary Soils Of Sone Irrigation Scheme In Bihar, India

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Abstract
Soil Irrigability classification is concerned with determining the feasibility of soils for irrigation based on quantitative limits of soil parameters relevant to irrigation. Land capacity categorization takes into account soil irrigation classes, topographic factors, and the location of the groundwater table to determine the overall feasibility of lands for irrigation. In this study, soil irrigability and land capability for the Paliganj distributary of the Sone irrigation scheme in India are classified using the modified approach of soil and land suitability classification suggested by Palaskar and Varade. For the present study, soil samples are collected from ten different locations at Paipura, Fathepur, Kurkuri, Sarsi, Shiyarampur, Bara, Satpura, Pipardah, Indrapuri, and Khapura. The total aggregate indices and their soil Irrigability classes for above mentioned ten locations are found to be 3.63(B), 3.76(B), 3.73(B), 3.73(B), 3.73(B), 4.71(A), 4.55(A), 4.34(A), 3.65(B), 4.78(A) respectively. After analyzing soil Irrigability classification, four locations come under none to slight soil limitation for sustain use under irrigation and the remaining six locations have moderate soil limitation for sustained use under irrigation. The land capability classes of all the ten locations come under category I, which indicates that the land is having no limitations for agriculture production. For this land classification, perennial crop percentage areas are 12 to 15 %.
Keywords: *Soil Irrigability classification, Land Capability classification, Aggregate index, Perennial crops*

INTRODUCTION

The evolution of an irrigation network to serve the world's growing population is a global concern. To increase agricultural productivity, a significant investment has been undertaken in the country to create reliable irrigation systems through major and minor irrigation projects (Gajja. B.L.et al. 2006). The country's irrigated area improved from 21 Mha in 1950-51 to 68.1 Mha in 2013-2014. The use of land and water resources is a major issue in the arid and semi-arid regions, which comprise more than 60% of the country's land area. The semiarid tropical zone provides for over 75% of all cropped land. Andhra Pradesh, Telangana, Maharashtra, Tamil Nadu, Karnataka, and Rajasthan are the states with the most drought-prone districts, with 265 million people affected. To maintain current levels of soil productivity and prevent degradation, scientifically-based management of soil resources is required. As a result, in recent years, more attention has been placed on soil characterization, reliable mapping of soils, and the development of rational and scientific standards for evaluating land for its many purposes. This necessitates a thorough understanding of soil resources, including soil types, spatial extent, physical and chemical qualities, and limitations and capabilities (Biplab Mandal et al, 2017, Manoharachari et al, 2017, Mani Bhushan et al, 2018, Ramesh Kumar et al, 2018). According to Thornthwaite's (1931) methodology, the climate in the research region is sub-humid. The categorization of soil irrigability may be based on a soil survey handbook (1970). In this classification, soil irrigability is split into five groups: irrigable soil classes A through D, and non-irrigable soil classes E and F.

Almost all developing countries are concerned about the development and optimal usage of both land and water resources. The yield levels of the crops being farmed in the command area can be used to determine water productivity. Water and soils are important limiting elements in the development of existing land resources in both humid and dry regions. However, making wise use of these resources,

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which are become limited and expensive by the day, should be a top priority in order to assist the irrigation of more land. India is the world's seventh-largest country, with 329 million hectares. India is the second most popular country in the world. The gross cultivated area is around 189 million hectares, with a net display area of approximately 142 million ha, of which only 39 percent is irrigated. According to projections, India will need to produce 367 million tons of food grains by 2025 and 581 million tons by 2050 to reach marginal food sufficiency.

According to Gajja et al. (2006), farmers in Gujarat's Mahi right bank (MRB), Ukai-Kakrapar right bank (UKRB), and Kakrapar left bank (KLB) canal command areas have deviated from the prescribed cropping pattern and are cultivating high water-demanding crops regardless of their compatibility to the terrain. Sugarcane and rice farming in Irrigability Classes III, IV, and V has resulted in waterlogging and secondary salinization issues, resulting in lower crop yields. Climate, soil, irrigation, tillage practices, improved seeds, fertilizers, plant protection measures, credit and extension services, and other factors all influence crop yields (Anon., 1971).

Soil is the most crucial of these inputs. Hence, the main objective of the present study is the soil characteristics and topography (slope) of the land inside the field must be thoroughly evaluated in order to determine the appropriateness of the area for surface irrigation (Jaruntorn et al. 2004; Fasina et al. 2008; Lillesand et al. 2014).

The Study Area

The Sone command area aggregate catchment zone of the waterway is 71,259 sq. km, of which 17,651 sq. km lies in Bihar. The remaining 53,608 sq. km lies in Chhattisgarh, Madhya Pradesh, Uttar Pradesh, and Jharkhand states of India. The Sone Canal System in South Bihar includes the Paliganj Distributary. The Sone River travels northeast from the Deccan Plateau before entering the Ganges not far from Patna. The Sone Canal System diverts water from the river to irrigate a design command area of more than 700,000 hectares. A branch of the Patna Canal, the Paliganj distributary is located 75 km from the canal's head at the Sone Barrage. Their two sub-distributaries are Chandos and Bharatpura. This system irrigates 4500 acres of agricultural area across its approximate 40 km overall length (sub-distributaries included). Channels of this system meander through Paliganj and Dulhania Bazar blocks in Patna and Arwal block of Arwal district which incorporates more than 50 villages. A total ten soil samples were collected from the Paliganj distributary (Paipura, Fathepur, Kurkuri, Sarsi, Shiyarampur, Bara, Satpura, Pipardah, Indrapuri, and Khapura).

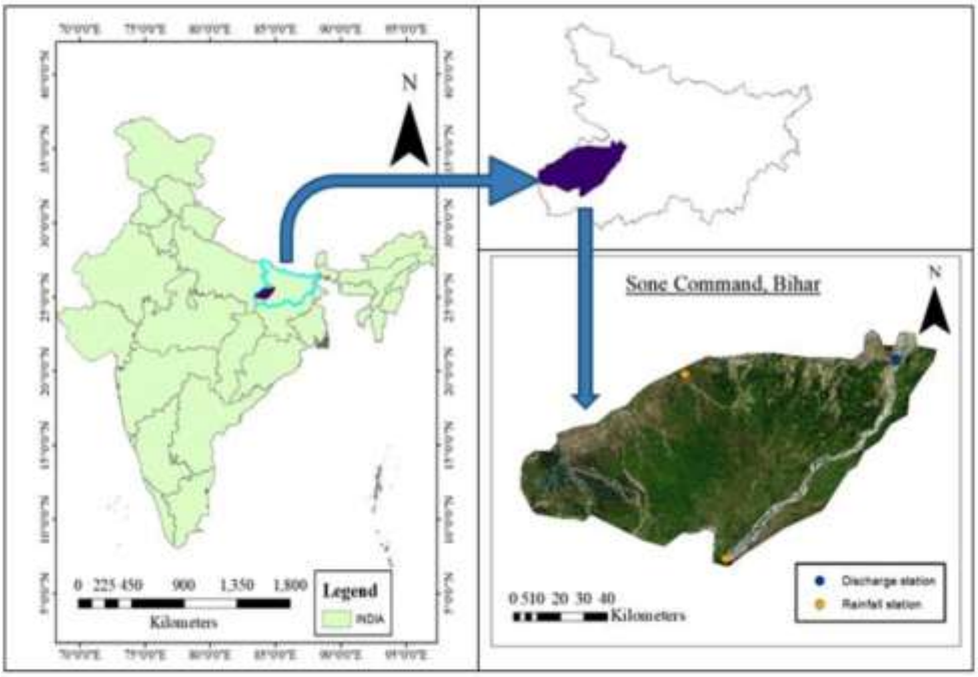

Fig-1: Sone Command Area

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Fig-2: Paliganj Distributary Index Map, Sone canal system
(**Source:** Bihar State Second Irrigation Commission)

MATERIALS AND METHODS

The system's tools are soil survey maps and reports, which are used to classify the entire watershed, based on soil and land use capability characteristics. Soil surveys are used to classify the physical and chemical properties of a region's soils. During the Bureau of Reclamation's massive irrigation construction effort in the Western United States in the early 1900s, land classification became popular. Many soils are quite simple to irrigate, requiring only a basic understanding of soil properties on the side of the irrigation engineer. When determining Irrigability, various assumptions must be made about the irrigation methods that will be used.

The distribution of land use/land cover is one of the types of evidence of resource consumption and management, providing a foundation for planners to plan for long-term land use. In general, unlike highly aggregated data at the national level, the micro-level study provides a detailed picture of the problem at the local level, where the plans will be implemented. As a result, distributary assessments are critical to ensuring the long-term viability of the land resource. Certain soil and land features are important to the design and operation of every irrigation system in any project. Soil Irrigability classification is concerned with determining the appropriateness of soils for irrigation based on quantitative limitations of soil properties relevant to irrigation. Soil irrigable classes, topography characteristics (slope), and groundwater level's location (depth to groundwater table from the surface) are used to determine the overall feasibility of areas for irrigation and to set the proportion of perennials ('X' limit) in the command. Land Irrigability classification also reveals the size of the irrigable region. As a result, every soil survey report should be evaluated in terms of soil and land Irrigability categorization.

Classification of Soil Irrigability

For the purpose of assessing soils for flow irrigation and agricultural farming, five soil Irrigability classes have been developed. These classes' definitions are listed in Table 1. In addition, the weights assigned to various soil properties are listed in Table 2. The information in this table is a revision of the original Rege, et al. (1974) criteria presented by Palaskar and Varade (1985) and accepted by WALMI Aurangabad (D. A. Concepts and Techniques, 1989) accepted by WALMI Aurangabad (D. A. Concepts and Techniques, 1989).

Table 1. Classification of Soil Irrigability

Aggregate Index	Soil Irrigability Classes	Significance
5 - 4	A	None to slight soil limitation for sustain use under irrigation
4 - 3	B	Moderate soil limitation for sustain use under irrigation
3 - 2	C	Severe soil limitation for sustain use under irrigation
2 - 1	D	Very Severe soil limitation for sustain use under irrigation

Table 2. Soil Characteristics for Modified Soil Irrigability Ratings and Points/Weightages Allotted to Different Soil Characteristics as per Palaskar and Varade (1985)

Classification of Land Irrigability

Soil Characteristics		**Soil Classes**				
		A	B	C	D	E
	Max. Points Earned	**5**	**4**	**3**	**2**	**1**
Effective Soil Depth (cm)	5	>90 very deep	45-90 deep	22.5-45 medium	7.5-22.5 shallow	<7.5 very shallow
Soil Textural Group	5	SiL, CL, L	C, SiC, SC	SL	LS	S, Si
Soil Structure	3	Crumb, granular	Angular, Sub-Angular blocky	Platy	Columnar, Prismatic	Massive single grained
Available Water capacity in effective profile depth (cm)	5	>21	21-14	14-7	7 - 2	<2
Basic Infiltration rate (cm/hr)	4	0.7-3.5	3.5-6.5	6.5-12.5	0.3-0.7	>12.5 or <0.3
Saturated hydraulic conductivity (cm/hr)	4	6 - 2	2-0.5	12.5-6	25-12.5 or 0.5-0.25	>25 or <0.25
Salinity						
EC, mmhos/cm at 250C of	3	<4	4 – 8	8 - 12	12 - 16	>16
soil sodicity (ESP)	3	<15	15-35	20-30	30-40	>40
Surface Covers						
Gravels (0.2 cm to 7.5 cm dia) % by Volume	3	<15	15-35	35-55	55-70	>70
Rock out-crops Distance in meters	3	>40	20-40	15-20	5 - 15	<5

Land use capacity assessment may be characterized as a system that categorizes lands based on their potential to create a yield. This system of land classification is based on a basic guideline based on the potential capacity of different types of soil for agricultural purposes, i.e. how much soil and land are accessible for various farming operations. It's also a useful classification of soil based on different soil constraints. Land categorization denotes how soil is used within certain constraints and ensures appropriate protection from erosion and other causes of degradation.

An area with a greater soil depth, well-drained soil, and a stable structure, with a slope ranging from 1% to 3%, can be used in large proportions with little risk of erosion or loss of productivity; such an area has fewer limitations and greater capability for its use, based on which the particular soil can be classified. In other cases, a location with shallow, poorly drained soils or steep slopes has various constraints and limited potential for usage, and is placed in a different class. A land of a specific capacity class has a specific potential ability for that class land's usage, but not for all classes below it. For example, a field suited for producing crops without soil conservation techniques, which is a property unique to class I, is

not applicable to other classes. Similarly, land utilized for grazing, forestry, and wildlife but not for agricultural production is recommended to be kept in classes V to VIII, but not in classes I to IV. A capability class does not suggest the optimum use of the land; rather, it reflects the range of possible uses for each area; the farmer or his adviser makes the ultimate decision.
Six land Irrigability classes have been developed, based on soil irrigable class, land slope, and groundwater levels location as per the criteria listed in the table. The land class is determined by the most restricting characteristic. Table 4 lists the various land capability classifications. Table 5 also contains the requirements for land capability classes.

Table 3. Land Irrigable criteria and Classification

Land Capability Class	X limit in percentage
I	12-15
II	9-12
III	6-9
IV	3-6
V and VI	NILL

The 'X' limit, percent area under perennial crops are determined by the classification of land Irrigability. The 'X' limitations are as follows. It indicates that soils with land Irrigability ratings of V or VI are unsuitable for perennial crop production

Table 4. Percentage area under perennial crops according to Land Capability class

Land Characteristics	**Land Irrigability class**					
	I Land with no limitations	II Land with moderate limitations	III Land with severe limitations	IV Land with very severe limitations	V Temporarily unsuitable Land	VI Unsuitable Land for Irrigation
Soil Irrigability Class (Aggregate)	A	A or B	A or B or C	A or B or C or D	Temporary Field Investigation	E
Land Slope (%)	< 1	1-3	3-5	5-10	10-15	>15
Depth of GWT from GL (m)	>3	2-3	2-1	<1	-	-

RESULTS AND DISCUSSIONS

Climate, geography, and the availability of irrigation systems all influence the suitability of soil for certain crops (slope, land development, drainage, physical and chemical characteristics of soil). Effective soil depth, texture, structure, available moisture capacity, infiltration rate, stream size, and permeability are some of the physical properties of soil. Soil salinity, sodicity, and water quality are three chemical properties of the soil.
After air and water, the land is one of the most valuable things that nature has given to mankind. It offers us food, clothing, and shelter, all of which are necessary for our health. Any soil survey provides data that may be used to classify soil and land Irrigability. The high expense of developing irrigated agriculture must be justified by a risk-benefit analysis, and the design of the irrigation scheme is reliant on a thorough understanding of the soils inside the irrigable region.
The observed data, the results of field tests, and soil Irrigability class of Paipura location are given in Table 5. After analyzing all ten locations of soil samples with Palaskar and Varade (1985), the results of the total points earned, aggregate index, and Soil Irrigability class are given in Table 7, from which it is found that four locations come under Soil Irrigability of Class A, which means None to slight soil limitation for

sustain use under irrigation and the remaining six locations come under soil Irrigability class of B, which means Moderate soil limitation for sustain use under irrigation. The land capability class of all locations comes under I group, which means Land with no limitations. The details of all location's land capability classes are given in table 8. The percentage area under perennial crops in all ten locations is 12-15 percent.

Table 5. Observed data for location Paipura

Soil Characteristics	No. of Credits Allotted	Observed Soil Property	Soil Irrigable Class	Point Earned	Total Point Earned
Effective Soil Depth (cm)	5	>90 cm	A	5	25
Soil Textural Group	5	SW	E	1	5
Soil Structure	3	Massive single grained	E	1	3
Available water capacity (cm)	5	28.44	A	5	25
Infiltration rates (cm/hr)	4	4.14	B	4	16
Saturated hydraulic conductivity (cm/hr)	4		E	1	4
Salinity					
EC of saturation extract (m mhos/cm)	3	1.11	A	5	15
Soil Sodicity (ESP)	3	17.85	B	4	12
Surface Covers					
Gravels by Volume	3	0.2	A	5	15
Rock Out Crops Distance (m)	3	Nil	A	5	15
Total	38				165
Aggregate Index = 165/38 = 4.34 i.e. Soil Irrigable Class of Paipura is A					

Table 6. The soil Irrigability classification of ten locations

Sl. No.	Location	Total Points Earned	Aggregate Index	Soil Irrigability Class
1.	Shiyarampur	138	3.63	B
2.	Satpura	143	3.76	B
3.	Bara	142	3.73	B
4.	Sarsi	142	3.73	B
5.	Pipardah	142	3.73	B
6.	Kurkuri	179	4.71	A
7.	Khapura	173	4.55	A
8.	Paipura	165	4.34	A
9.	Fathepur	139	3.65	B
10.	Indrapuri	182	4.78	A

Table 7. Land Irrigability Classification

Sl. No.	**Location**	**Soil Class**	**Land Slope**	**Depth of GW (m)**	**Land Class**
1	Shiyarampur	B	0.0122	3.88	I
2	Satpura	B	0.0120	5.56	I
3	Bara	B	0.0165	4.95	I
4	Sarsi	B	0.0130	3.75	I
5	Pipardah	B	0.0120	7.80	I
6	Kurkuri	A	0.0153	5.67	I
7	Khapura	A	0.0153	6.55	I
8	Paipura	A	0.0153	4.58	I
9	Fathepur	B	0.0165	5.84	I
10	Indrapuri	A	0.0120	4.76	I

CONCLUSIONS

The soil Irrigability class of forty percent locations come under the A category, which indicates no slight soil limitation for sustained use under irrigation. The remaining sixty percent of locations come under the B category, which indicates moderate soil limitation for sustained use under irrigation. For land capability classification, all locations in Paliganj distributary come underclass I category which means land with no limitations for agriculture production, and also X limit of these locations is 12 to 15% i.e., percentage area for perennial crops. This study indicates that Soil Irrigability and land capability classification must be interpreted in any irrigation project so that they can be employed on a long-term basis.

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