Challenges of Large-Scale Irrigation Project Development in Nepal : A Case Study of the Sikta Irrigation Project

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Outlines of the Presentation

1. Irrigation Development History
2. Sikta Irrigation Project-Introduction
3. Major Challenges
4. Dispersive Soil and Corruption Case
5. Major Takeaways

1. Historical Development

Broadly Categorized under Four Phases

1. Before 1950s – Farmer Managed Irrigation System

2. 1950 -1980 - Infrastructure Development Phase (Extensive Dev.)

3. 1980- 2000

- ❖ Intensive Development Phase
- ❖ Basic Need Fulfillment
- ❖ Irrigation Master plan, 1990
- ❖ Focus on Government - Farmer's Partnership
- ❖ Priority on Ground-Water Irrigation

4. 2000 onwards –

- ❖ Large Scale, Multipurpose Irrigation Project
- ❖ Focus on reliable Year-round irrigation

Historical Development - Achievements

- **We ourselves can plan, Design and Implement all type of irrigation projects from *Kulo* to Inter-basin Water Transfer**
- **We are able to manage Investment required for our *"Dream Projects"* from our own Resources**
- **Irrigation Development from 3.5 Lac ha. (1960) to 15.7 ha. (2025)**

Rani Jamara Kulariya Irrigation Project

Babai Irrigation Project

Sikta Irrigation Project

2. Sikta Irrigation Project

Historical Background

- **1975-1978:**
  - Pre-Feasibility Study (West Rapti Multipurpose Project)
- **1980 :**
  - Feasibility Study Report by Lahmeyer International
  - Technical Assistance by ADB and UNDP
  - Soil Tests Carried out in the AIT Bangkok Laboratory
- **1983 :**
  - Detail Feasibility Report
  - Department of Hydrology and Meteorology
  - Constructed 3km Canal and Project Camp at Nepalgunj
- **2004 :**
  - Updated Detail Feasibility Report
  - Financial Support from European Union (EU)

2. Sikta Irrigation Project

Historical Background……

- The GoN tried to receive financial support from different International Development Agencies
  1. Asian Development Bank (ADB)
  2. European Union (EU)
  3. Saudi Fund for Development (SFD)
  4. Kuwait Fund for Development

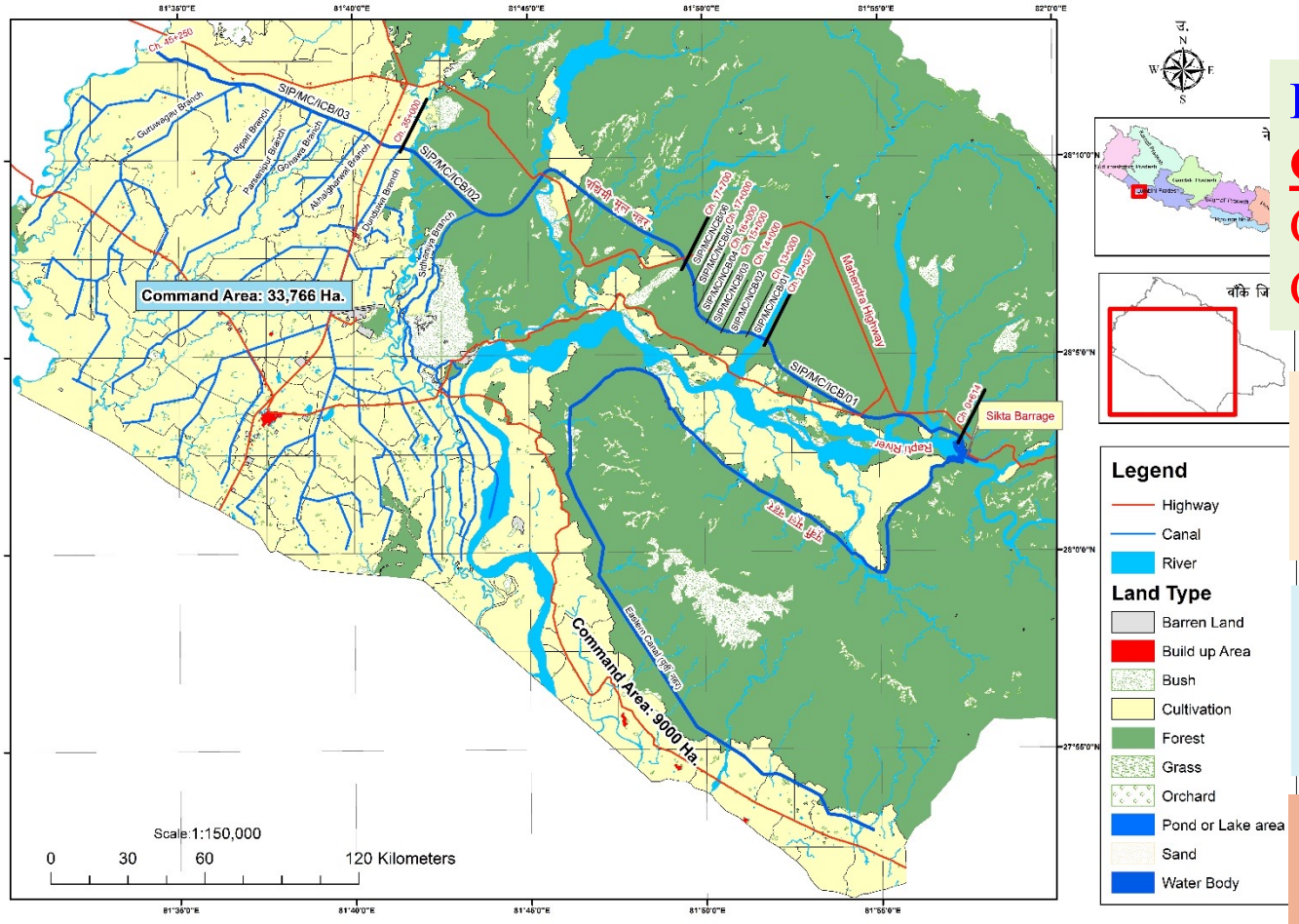
- 31 May, 2004:
  - Project is approved by the NPC for Implementation

- 1 June, 2004 :
  - Indian Embassy sent letter to the GoN not to proceed the project
  - All the IDA agencies refused to support the Project

- 7 March, 2005 (B.S. 2061/11/24):
  - The GoN Decided to implement the project with its own resources

2. Sikta Irrigation Project

Project Features



Barrage: 317m

Canal:

Canal (West): 50 km

Canal (East) : 53.5km

Design Discharge:

West Canal: 50 m3/sec

East Canal: 14.9 m3/sec

Project Cost:

Original: Nrs. 12.5 Billion

Current: Nrs. 52 Billion

Project Priod:

Started: F.Y. 2062/63

Completion: F.Y. 2089/90

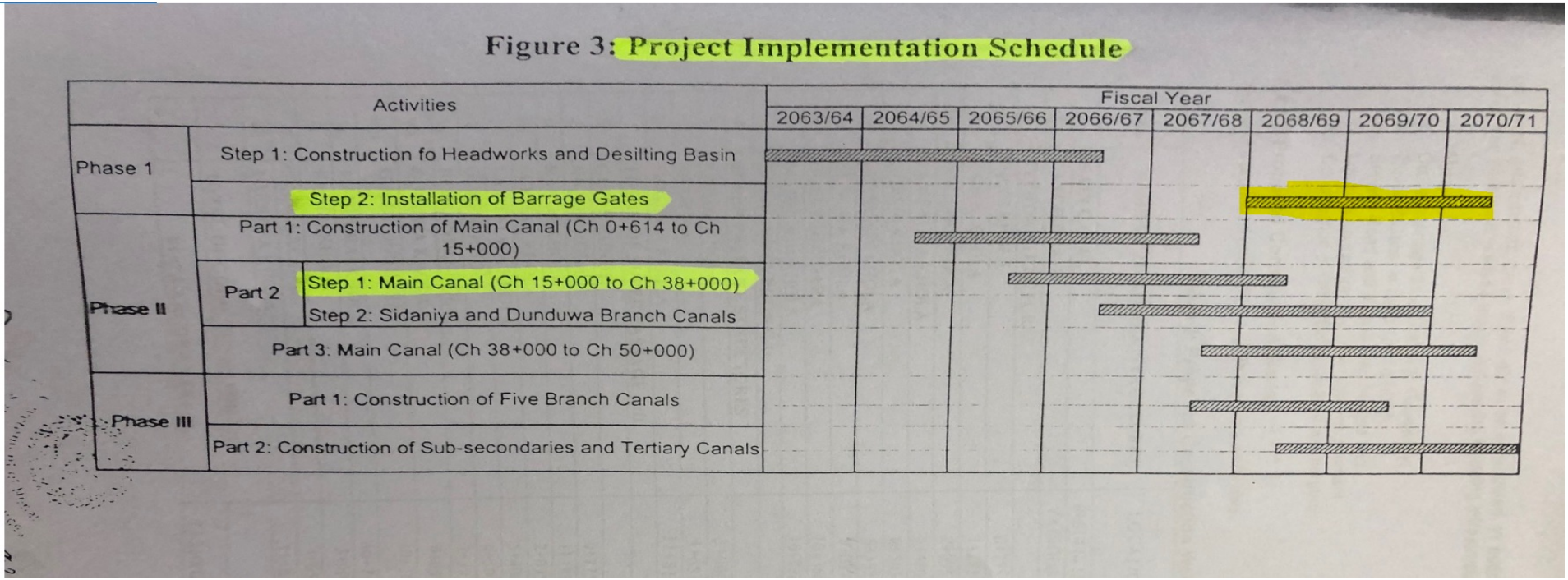
- **Command Area**
  - **42,766 ha. (West: 33,766 ha. and East: 9,000 ha.)**

2. Sikta Irrigation Project

Construction Planning

1. Phase I: Construction of Headworks
2. Phase II: Main Canal and Secondary Canals
3. Phase III : Sub-Secondary, Tertiary and Command Area Development (CAD)

Figure 3: Project Implementation Schedule



2. Sikta Irrigation Project

Current Status *(Source: Sikta Irrigation Annual Book 2081/82)*

1. **Phase III : Sub-Secondary, Tertiary and Command Area Development (CAD) work is ongoing**

2. **Total 22,500 ha. Area (West: 18,500 ha. and East 4,000 ha.) is getting irrigation**

Before Sikta (Dec 2016)

After Sikta (Dec 2024)

Source: Sikta Irrigation Annual Book 2081/82

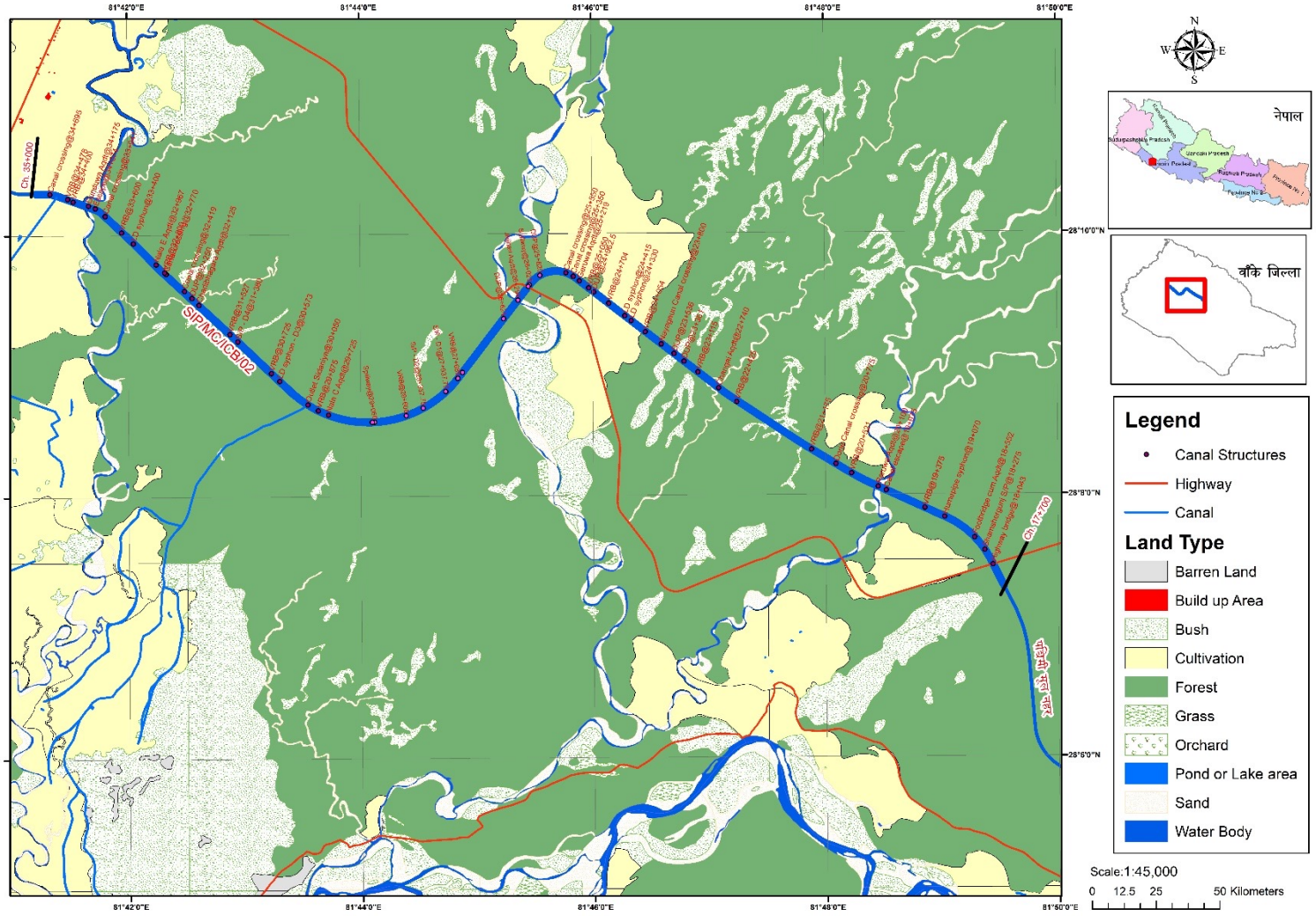
3. Major Challenges

1. Management of Financial Resources and Objection of d/s riparian country

2. Canal Alignment and Rugged Topography- Deep Cutting up-to 30m and Canal bed filling up-to 10m

3. Major Challenges….

3. A large number of crossing structures located at the base of the Churiya range



3. Major Challenges….

4. Banke National Park, River aggradation and Overbank flow in the canal

3. Major Challenges….

7. Presence of "Dispersive Soil" in some sections

About 15 m Canal collapsed during First Test Run (28 June, 2016)

About 7 m Canal collapsed during Canal Operation (26 July, 2018)

4. Dispersive Soil and Corruption Case

When and how was **dispersive soil** first recognized in the field?

2006/2007

Project Start

First Test Run (28 June, 2016)

Conformed by the Test (Dec. 2016)

Queries through Research Gate/Google

Canal Collapsed Second Time (26 July, 2018)

Corruption Case filed on (7 Dec. 2018)

4. Dispersive Soil….

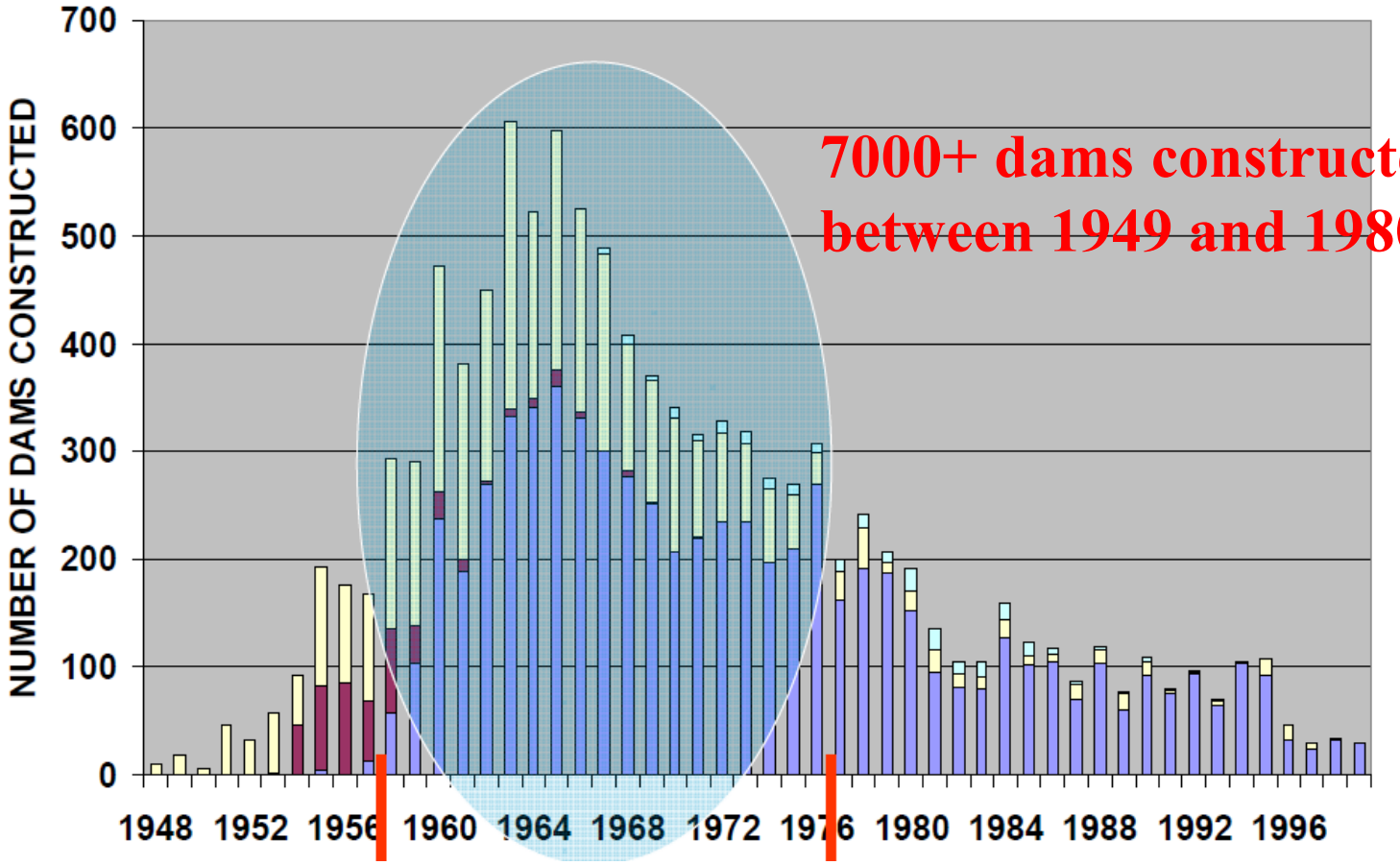
When and how was **dispersive soil** first recognized in the field?

4. Dispersive Soil ….

Jugholes found in the Embankment Top and Canal Berm

4. Dispersive Soil….

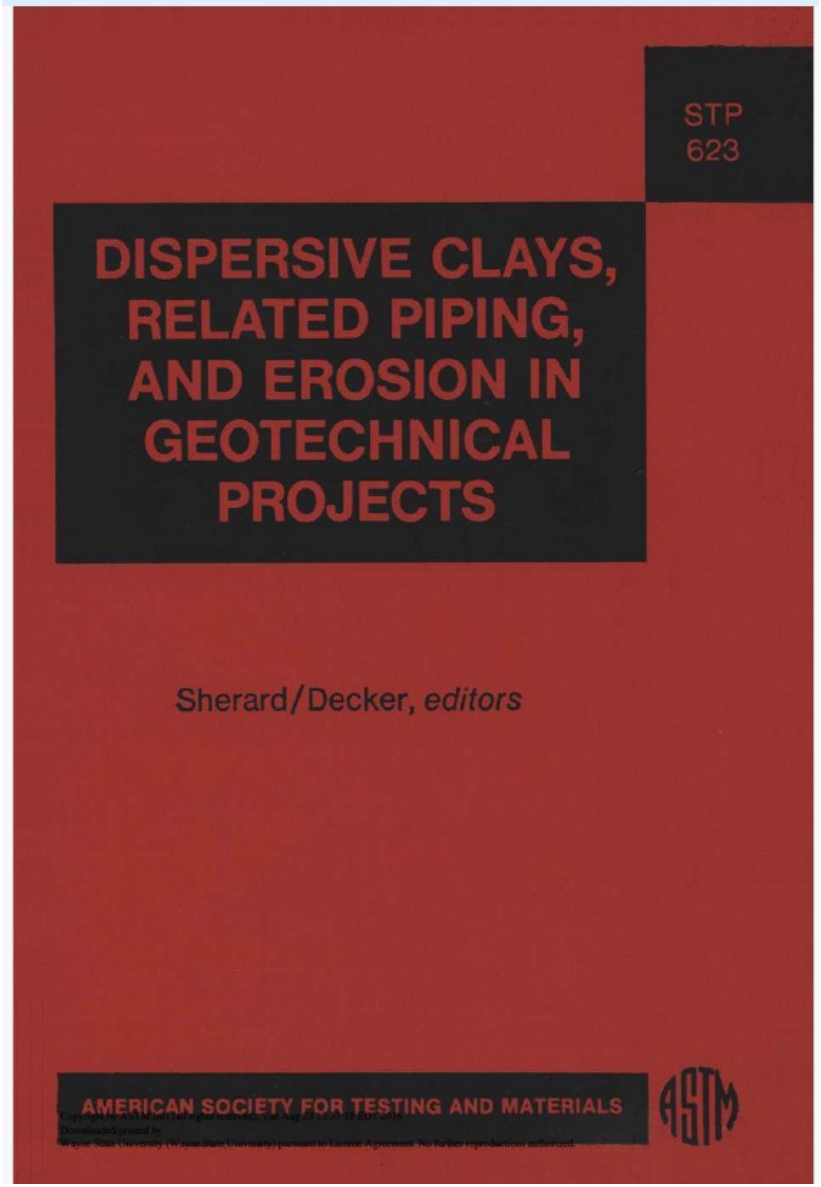
Dam Construction History of NRCS (Formerly SCS)



- Ten of 11 OK dams failed on first filling,

- Universal reason for failure was “Dispersive Soil”

4. Dispersive Soil….



STP 623-ASTM 1977

United States Department of Agriculture
Soil Conservation Service
P.O. Box 2890
Washington, D,C.
20013

February 21, 1991

SOIL MECHANICS NOTE NO. 13
210-VI

SUBJECT: ENG - DISPERSIVE CLAYS

Purpose. To distribute Soil Mechanics Note No. 13 (SMN-13).

Effective date. Effective when received.

Dispersive clay soils can be a problem for many SCS practices or structures. In appearance, they are like normal clays that are stable and somewhat resistant to erosion, but in reality they can be highly erosive and subject to severe damage or failure. It is important to understand the nature of these materials and to be able to identify them so they can be avoided or treated.

SMN-13 summarizes the properties of dispersive clay soils, discusses the proper way to investigate for them and outlines the ways to test for them in the laboratory or field. Defensive design measures are given and remedial treatments explained.

Filing Instructions. File with other soil mechanics notes with guide material on dispersive soils or on construction with soils.

Distribution. This soil mechanics note will be of interest to soil engineers, design engineers, area engineers, project engineers, engineering geologists and others who may be conducting investigations for designing, or constructing practices or structures where dispersive soils may be found. The initial distribution to each state and NTC is according to requested numbers indicated in a survey for SMN-1 (shown on the reverse side). Additional copies may be obtained by ordering SMN-13 from Central Supply.

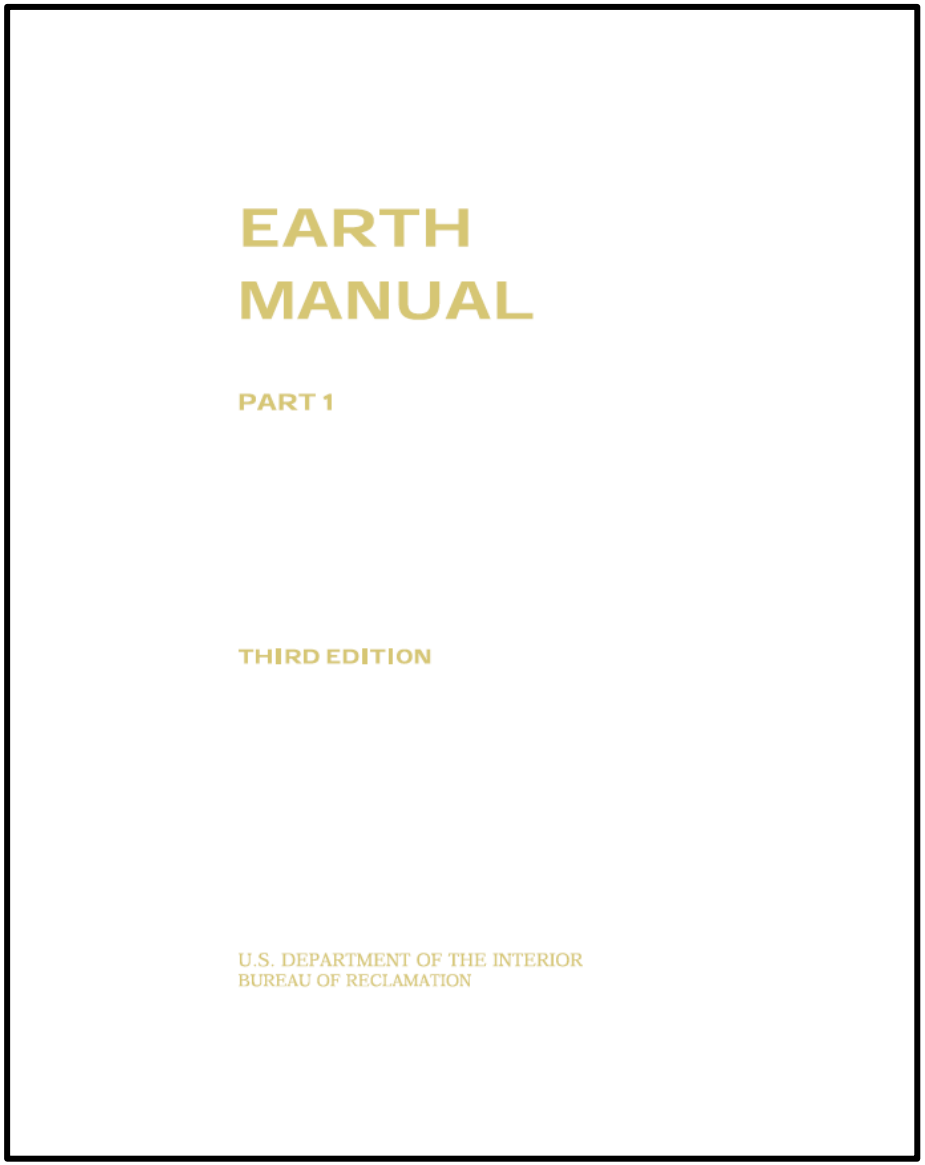
Edgar H. Nelson

EDGAR H. NELSON
Associate Deputy Chief
for Technology

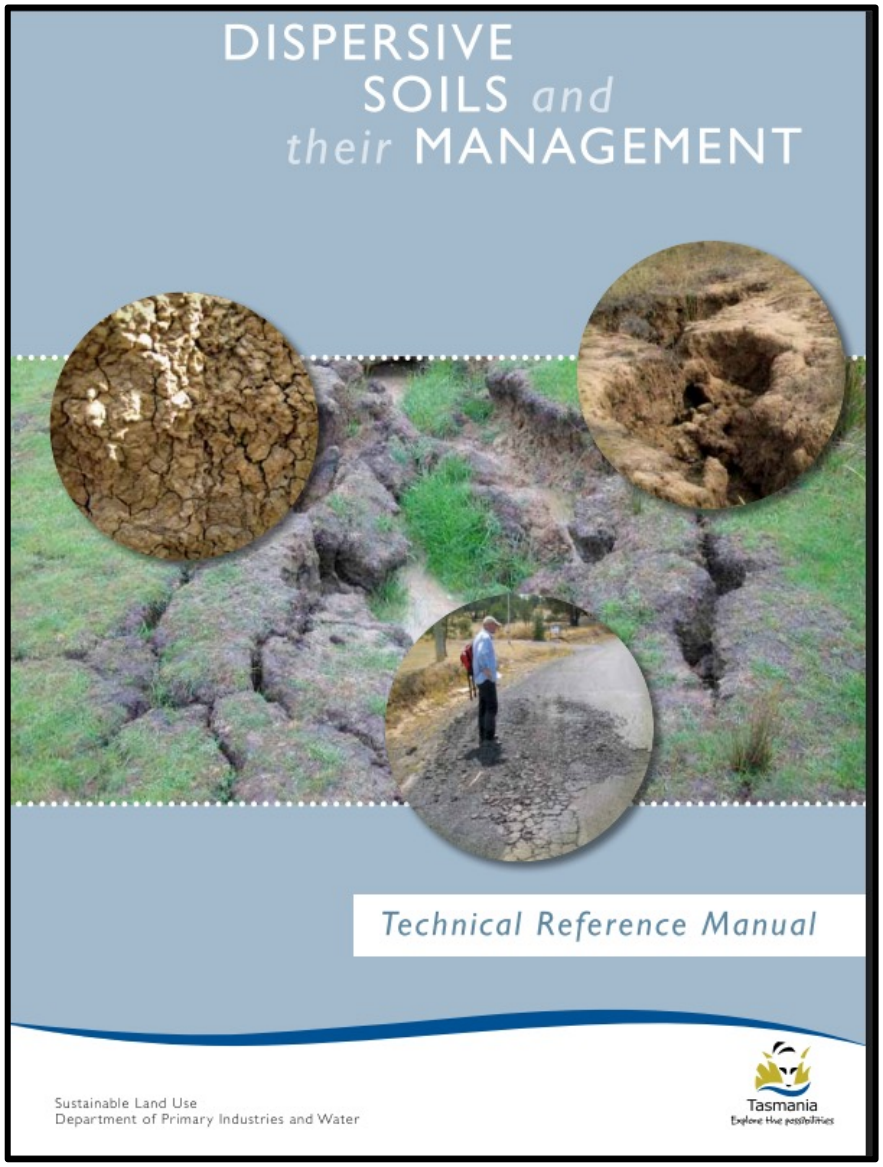
DIST: SMN-13

USDA-SCS 1991 Soil Mechanics Note

4. Dispersive Soil….



USBR Earth Manual, Part I, 1991



Tasmania Reference Manual, 2009

Experience of Other Countries

Failed Canal Lining and Sink Hole on the Embankment in Moghan Irrigation Project, Iran (Photo : Rahimi et al. 2011)

The Canal was 28 km long and command area 16,000 ha.

Rahimi H., Abbasi and Shantia H. 2011. Application of geomembrane to control piping of sandy soil under concrete canal lining (Case study: Moghan Irrigationn Project, Iran). *Journal of Irrigation and Drainage 60: 330-337*.

Experience from Other Countries

Catastrophic Failure of Huesca Dam, Spain, 2001

Gutiérrez et al. (2003). Causes of the catastrophic failure of an earth dam built on gypsiferous alluvium and dispersive clays (Altorricón, Huesca Province, NE Spain); Environmental Geology (2003) 43:842–851

Experience from other countries….

lting from topsoil removal, surface water has dissolved through the soil surface. Soils derived from Triassic

Figure 28. Rill and tunnel erosion caused by excavation of sodic soils for road construction. Dunalley.

Case in Tasmania, Australia

What are Dispersive Soils?

DEFINITION

Dispersive clays differ from ordinary, erosion resistant clays because they have a higher relative content of dissolved sodium in the pore water. Dispersive clays have a preponderance of sodium in the pore water, whereas ordinary clays have a preponderance of calcium and magnesium cations. Dispersive clays erode as the individual colloidal clay particles go into suspension in practically still water, whereas considerable velocity in the eroding water is required to erode normal clays.

Standard soil mechanics tests, such as mechanical grain size distribution analyses (gradation) and Atterberg limit tests, do not distinguish dispersive clays from ordinary clays. A special group of tests is needed to identify dispersive clays.

Laboratory Tests

1. Crumb
2. Double Hydrometer
3. Pinhole
4. Chemical Test on Pore Water Extract

Ref: USDA-SCS 1991 Soil Mechanics Note

Dispersive Soil Test Report of Sikta Irrigation Project (Dec. 2016)

SIKTA IRRIGATION PROJECT, BANKE

SOIL TEST REPORT

On

SIKTA IRRIGATION PROJECT SITE, BANKE

Submitted By:

GEOTECHNICAL AND ASSOCIATES PVT. LTD.

BOKHUNDOLE, LALITPUR

NEPAL

DECEMBER, 2016

Table 3 - Summary of Double hydrometer test results

S. No.	Sampling Locations	Soil Dispersion in %	Remarks
1	Chainage (17+407)	55.88	Dispersive
2	D/s of Paruwa aqueduct, right side (19+900)	35.41	Intermediate
3	Balapur deep cutting area (21+221)	42.5	Intermediate
4	Chainage 22+757	56.44	Dispersive
5	Dhakeri village, u/s: disturbed, left side (23+207)	29.1	Non dispersive
6	Dhakeri village, right side (23+996)	45.55	Intermediate
7	Jhijhari River (Right bank: probable soil quarry site)	11.32	Non-Dispersive
8	Jhijhari deep cutting (26+435)	58.75	Dispersive
9	Jhijhari aqueduct downstream (26+124)	58.46	Dispersive
10	Highly disturbed part: 1 (27+773)	48.78	Intermediate
11	Highly disturbed part: 2 (31+207)	60.64	Dispersive
12	Chandi Bhagra Aqueduct, u/s right side (31+670)	43.26	Intermediate
13	Dunduwa filling(34+175)	57.14	Dispersive
14	Sidhania around (1+500)	33.33	Intermediate

Test Results using Double Hydrometer Test

5. Major Takeaway

1. Established Water Right in the West Rapti River
2. Model irrigation project for other large projects like Mahakali, Rani Jamara Kulariya, Bheri-Babai, Sunkoshi Marin Diversion etc.
3. Enhanced Technical Capacity of the Nation (Employer, Contractor and the Consultant)
4. Established mandatory test for dispersive soil in irrigation projects. Will also reference for Road, Transmission line, drainage and optical fibre cable trench
5. Case study for geopolitics, Engineering, and socio-economic challenges of the water resources (consumptive use) projects in Nepal
6. Increased confidence, self reliance, and dignity of the Nation

Sikta Irrigation Headworks and Main Canal

Thank you !