CHAPTER 3
MATERIALS AND METHODS

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The experimentation was carried out under three parts of study as follows .

1 Remote sensing technique in monitoring the waterlogged area.

2 Vegetational survey in the study area.

3 Ameliorative study under waterlogging condition.

The suitable materials used for each part of the experiments and the detailed methodology followed in these experiments were described in this chapter.

REMOTE SENSING TECHNIQUE IN MONITORING WATERLOGGED AREAS

Various data were used for the visual and digital interpretation technique to monitor waterlogged lands. The data used can be studied as,

PRIMARY DATA/ REMOTELY SENSED DATA

To monitor waterlogged area the multidate,multispectral multi seasonal, and multitemporal remote sensing data in the form of False Colour Composite(FCC) image or Computer Compatible Tapes(CCT) were procured from National Remote Sensing Agency (NRSA) Hyderabad or referred from image library of Space Application Centre(SAC) Ahmedabad.The data inputs are in detail as follows.

Land sat 4/mss FCC image of bands 5,6,7 acquired on May,1983 at 1:1 million scale of path 148 and row 044/045.

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Land sat 5/TM FCC paper print of bands 2,3,4 acquired on March,1986 at 1:250,000 scale of paths 148 and row 044/045.

1RS-1A /LISS-II FCC images of lands 2,3,4 of April 1988, March 1989 and November 1989 of path 31 and row 52.

1RS-1A /LISS-II Computer Compatible Tape of the April 1988 of path 31 and row 52.

ACCESSARY DATA INPUTS

Topographical sheets: The survey of India (SOI) toposheets numbered 468 at 1:250,000 and numbered 46 B-6,7,10,11 at 1:50,000 scales were used.

Cadastral maps: Revenue maps of Padra village of Khambhat taluka obtained from the Kheda collectorate at 1:8,000 scale were used for micro level study.

Hydrogeological map: Hydrogeological map of Khamphat taluka numbered 573/85 obtained from Gujarat Water Resources Development Corporation Ltd.(GWRDC) Gandhinagar at 1:126,000 scale was used.

ANALYTICAL PROCEDURE:

Different types of methodology has been carried out for Data collection, Image Interpretation, ground truth verification quantification and Area calculation.

Quick look Analysis: Selection of better quality in terms of cloud cover and signal to noise ratio, right scale, and selection of right seasonal data to approach pre and post monsoon climate,

selection of the image form to achieve the objective of the work, has been carried out by a quick look analysis. Using the light table and lense in visual interpretation unit Laboratory, Space Application center, Ahemedabad.

IMAGE INTERPRETATION:

Interpretation has been done by both manual/Visual and Digital interpretation techniques to identify, delineate and assess the Waterlogged areas. Multistage approach given to this study contributes much in the preparation of Interpretation key (in visual analysis) and in selection of training areas (in digital analysis) for efficient step by step interpretation.

VISUAL INTERPRETATION:

The aids used during the visual analysis of the images were Simple light table, Optical Reflecting Projector, Large Format Optical Enlarger and High Magnification Enlarger. The base map prepared from SOI index map on 1:250,000 and 1:50,000 scale with the help of simple light table was used to record the waterlogged areas from the images on 1:250,000 and 1:50,000 scale with the use of LFOE and HME respectively. Various categories of waterlogged areas, and vegetational status were identified delineated and mapped on the base map, based upon the image elements like tone, texture, shape and proximity etc. Priliminary map prepared by overlapping of photo interpreted map on 1:250,000 cadastral map with village bounderies and roads, using Optical reflecting projector, was used for the location of the study area in Khambhat taluka.

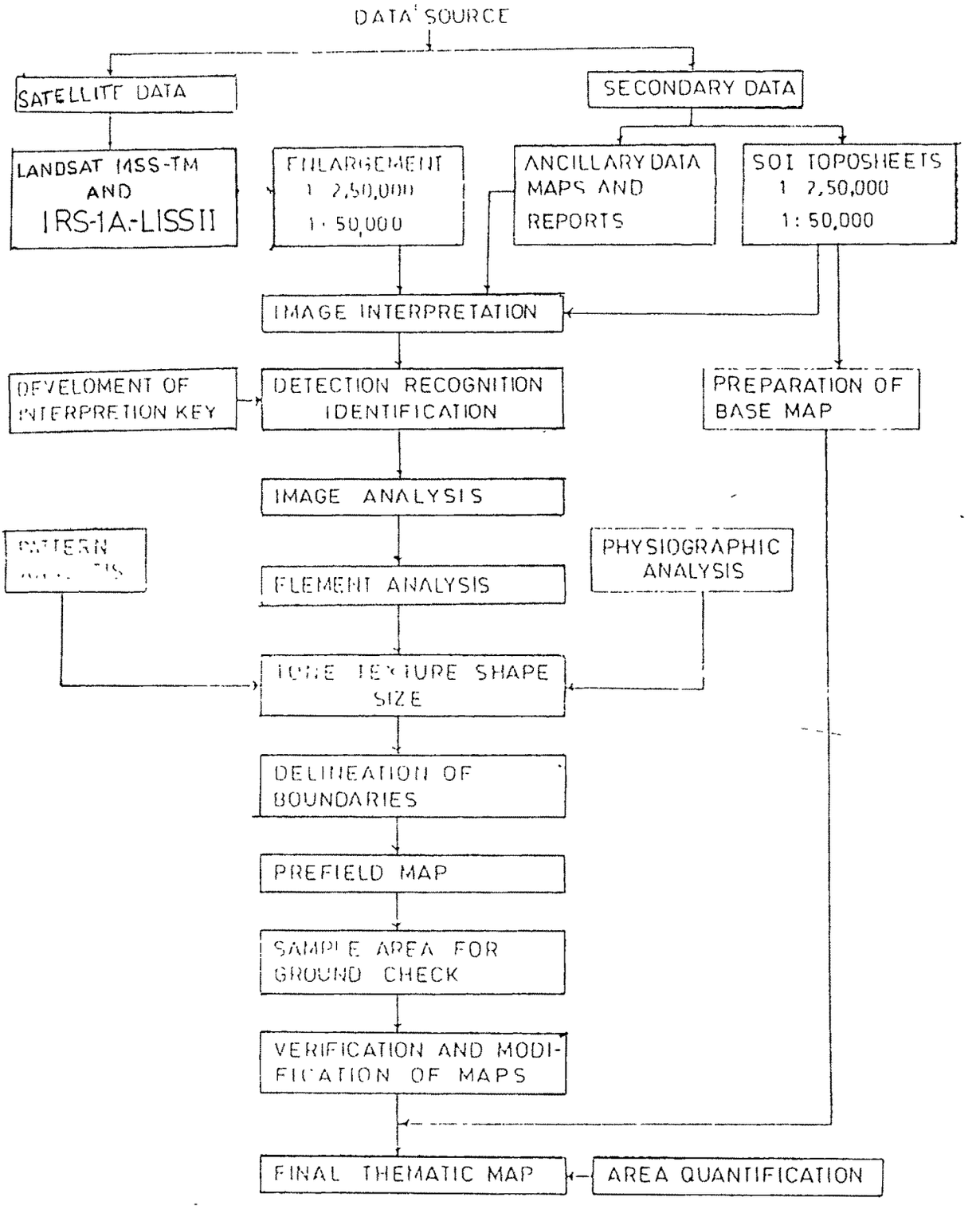

Fig 7 Scheme Illustrating Visual Interpretation

Preparation of maps at 1:250,000 and 1:50,000 scales.

Final maps were prepared after ground truth verification for waterlogged areas in Khambhat taluka at 1:250,000 scale using LFOE at the Dept. of Botany, M.S. University/Space application centre, Ahmedabad and 1:50,000 using HME (High Magnitude Enlarger) available in Space Application Centre, Ahmedabad aligning with the 1:50,000 toposheets.

Microlevel studies:

The enlarged photo interpreted map of 1:50,000 scale was used to transfer the data on the cadastral map of Padra village in an attempt to use the Remote sensing technique for plot wise study of the land degradation.

DIGITAL ANALYSIS:

In the present investigation although much of the work has been carried out by the visual interpretation technique, digital analysis was also attempted. The basic data constitutes available computer compatible tape (CCT) of IRS-IA/LISS-II scene path 31 and 52 of Khambhat taluka dated on 09 April 1988. The analysis was carried out on the VAX-11/780 computer system using VIPs - 32 image processing Software and a PC 2000 image display work station at Regional Remote Sensing Service Centre, Jodhpur. The steps for image processing were used for the digital analysis as in the fig..8.FCC colour composite with spectral band 2,3,4 was generated in the selection of training windows/ training areas for a supervised classification scheme to classify waterlogged

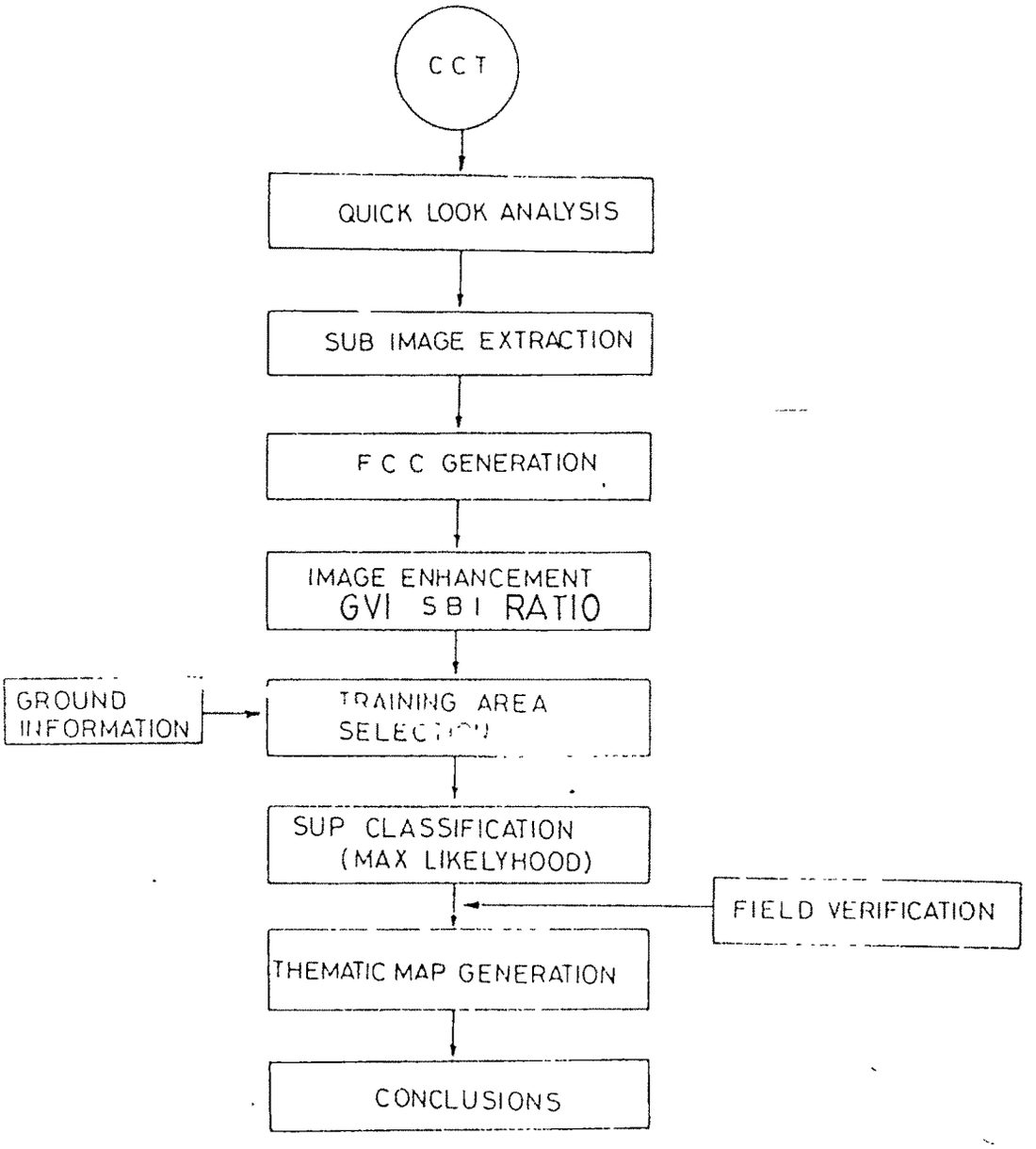

Fig.8. Steps involved in Digital Analysis.

lands and vegetation into different levels, by using the available ground truth data. Then the mean variance & co-variance matrices for different classes were extracted from the digital analysis.

In order to generate different levels of waterlogged land and vegetation, various indices were attempted using MSS tasseled cap co-efficient values suggested by Kauth and Thomas (1976) to IRS data.

1. SBI - IRS = (SOIL BRIGHTNESS INDEX)
   0.332 IRS 1. + 0.603 IRS 2 + 0.675 IRS 3 + 0.262 IRS 4

2. GVI - IRS = (GREENNESS VEGETATION INDEX)
   -0.283 IRS 1 + 0.660 IRS 2 + 0.577 IRS 3 + 0.388 IRS 4.

3. Ratioing: The ratio of IRS -1A bands 1 and 4 were attempted for identifying different types of waterlogged areas. The ratio colour composites of ratio combination 1/4 and 1-4/1+4 were generated to delineate waterlogged areas.

Dunn - out puts that were generated were taken in the form of coloured photographs.

GROUND TRUTH VERIFICATION:

The preliminary photo interpreted maps, with village boundaries and roads of both 1:250,000 and 1:50,000 scale were used for the ground truth study which is needed for

i) the calibration of sensors.
ii) the preparation of image interpretation key

iii) checking interpretation accuracy (Sahai, 1979) and also

iv) identifying the waterbodies, with its surface fully covered with dense aquatic vegetation.

Ground truth data collection was done by a frequent visits to the study site based on the Random sampling method using dot-grid technique. The interaction with the District Agriculture Officers, gram savakes and discussion with farmers were also included in this ground checking process.

AREA CALCULATION & QUANTIFICATION :

Besides the computation of waterlogged land by the digital analysis, the quantification was also achieved by 'Dot-grid' technique on the visually photo interpreted map. 1 mm transparent 'Dot-grid' was overlayed on the final interpreted map and the area for each category was computed as follows.

1 sq.cm (25 dots) of Dot grid = 6.25 sq.km on ground. For monitoring waterlogged area, the final maps prepared from the images of 1983 and 1986 were used. As a result of the partial coverage of the Khambhat taluka in the IRS-1A 1989, quantification was not attempted for the year 1989.

VEGETATIONAL SURVEY :

The survey of the natural vegetation in the different categories of study area viz. Normal land, surface moist land and flooded land was carried out to understand the land degradation due to waterlogging and salinisation. Important Value Index

(IVI), as integrated measure of the relative value of frequency, density and dominance of each different species was calculated following the method of Curtis(1959). Different Dominent diversity curves, were plotted using the important values like number of individuals, Biomass of species, IVI value against species sequence, as in the method of Whittaker (1965). Besides these Frequency diagramme for different community was prepared as it plotted by Raunkier normal frequency diagrame. In addition to these, few indices were computed as given below,

Simpson's Index, was used for species Dominance and species diversity indices.

Dominance index $C = E (ni/N)2$

where C = Dominance index
ni = number of individuals
N = Total number individuals

Diversity index forms $1 - E (ni/N)2$.

Shannon Index (H)

$$H = E\ pi \log pi$$

Pi = importance probality for each species = ni/N

Species Richness index (d)

$$d = \frac{S-1}{\log N}$$

where S = number of species
N = number of individvals.

Pielou's Evenness index (e)

$$e = \frac{H}{\log S}$$

where H = Shannon index
S = number of species.

AMELIORATIVE STUDIES:

The seeds of three cultivars of Pennisetum typhoides(Burmf) Staph & Hubb.viz, GHB-32, MH-179, BK-560 and a cultivar of Brassica juncea.(L.) Coss pusa bold used for different experiments, were procured from the State seed corporation of Gujarat, and model form of Gujarat Agricultural University, Vadodara. The amelioration of waterlogging effect using excass humus, spraying of aerial parts with polyamines and also selection of a suitable species to grow under waterlogged conditions was attempted in between the year 1988 and 1990. The randomized complete block design was used and each treatment was replicated five times (Table 3).

HUMUS APPLICATION

Seeds of GHB-32, MH-179 were sterilized with 0.1 % mercuric chloride and were sown in plastic pots (24 cm diameter x 23 cm deep.) filled with 7 kg of garden soil with normal and High humus content. Pot culture experiments were carried out in net house condition during the Kharief season of 1988. For high humus contant excess of garden manure was applied externally to the normal garden soil. Waterlogging treatment was imposed by maintaining the water-table permanently 2 cm below the soil surface However, in control, where the water was freely drained, watering was done whenever necessary to keep the soil moist. Thus the treatments were categorized as given below. Freely drained (FD) and waterlogged (WL) in combination with normal humus (NH) and additional high humus (HH). The pots used for the

TABLE 3- Different stages of the experiments

Material used	1 P.typhoides cv.GHB-32 MH-179	2 P.typhoides cv BK-560 MH-179	3 B.juncea Pusa bold	4 GHB-32	5 GHB-32	6 V.lawsoni
Seed sown	12-8-1988	22-6-1989	21-12-1989	6-2-1990	6-3-1990	12-9-1990
Treatment imposed*	11	13	19	19	33	29
I stage *	22	28	28	28	43	59
II stage*	39	41	-	39	53	84
IIIstage*	57	57	-	47	-	99
IV stage*	76	82	-	61	-	-

* Age of the Plant in days

waterlogging treatments, was fixed with the 'T' glass tube providing the facility for easy maintanence of the required water-table and also to facilitate easy drainage. The same experiments was repeated in the second year ie Kariff season of 1989 by using the seeds of cultivars MH-179 and BK-560 for confirmation of the first year results.

A winter crop *Brassica juncea* cv pusabold were also used for the ameliorative study by humus application under the same experimental design during Dec.1989.

APPLICATION OF GROWTH PROMOTERS (POLYAMINE SPRAY)

The seeds of the cultivar GHB-32,were grown in pot culture experiments in the net house conditions. The pot culture experiments were conducted in plastic pots filled with acid washed sand with proper drainage facility. Nutrients were supplied as standard Hoagland solution (Hoagland. 1947.)

The treatments were control (unflooded condition) and waterlogged in combination with or without the application of the respective growth promoter. The application of the growth promoter was given as sprays of Diamine Putrasine and Polyamines Spermine and Spermidine each of (10 µm concentration) to the aerial part of the plants once in a week.

Under non-flooded conditions, the plants were watered once per week with Hoagland solution in quantities sufficient to moisten the sand fully, but without allowing the accumulation of free liquid at the bottom of the buckets In the flooded buckets

same amount of nutrient medium was flooded will water to keep the lavel to the top of the sand. Once per week the solution was completely changed by draining and washing the sand with distilled water, before refilling the buckets with fresh Hoagland nutrient solution. Flooded of the plants was maintained through out the experiments.

CROP RESPONSES TO PUTRASINE SPRAY UNDER BOTH WATERLOGGING AND SALINITY STRESS:

This experiment was designed as that of the previous experiments. The cultivar GHB-32 was sown in sand culture with Hoagland solution as the nutrient medium, for saline treatments nutrient medium with NaCl of EC 10 mmhos/cm was used. Putrasine spray was given as a spray with 10 µm concentration to the aerial part of the plants.

GROWTH OF **Vetiveria lawsoni** Blatter et Mc cann UNDER WATERLOGGING AND SALINE STRESS

V. lawsoni Blatter et Mc cann was allowed to grow under waterlogged and saline stress in the net house conditions. Five clones of **V. Lawsoni** were planted on September 1990 in each plastic pots field with soil. The treatments were imposed after 25 days of plant growth. Waterlogging treatment was imposed by flooding the pots permanently and NaCl solution with EC 10 mmhos/cm was used for the saline treatment. Once in a week the pots of saline treatment was completely washed with distilled water before the buckets were refilled with fresh NaCl solution. The washing was found to be important to maintain the EC level of the solution.

GROWTH STUDIES:

The shoot system of the different crops was harvested at different stages of its growth often the implementation of the treatment in different experiments. The harvested plants at different growth stages were used to find out the length, the photosynthetic leaf area, their croping cover fresh weight and dry matter accumulation of the shoots. From these growth observation, the Leaf Area Index (LAI) Net Assimilation Rate (NAR) Relative Growth Rate (RGR) etc. were determined according to Kvet et al 1971.

REFLECTANCE STUDY :

An attempt has been made to study the differences in the spectral reflection of the shoot system of some crops under different conditions using the ground truth radiometer designed by Space Application Centre, Ahmedabad. This instrument is provided with multispectral bands corresponding IRS Landsat/TM and SPOT sattelite sensors. The 54 days old plants raised for the experiment 2.3 were used after 28 days of imposing the treatment waterlogging, salinity and its combination with putrasine spray as a ameliorative measure. L A I (Leaf Area Index) and leaf dry biomass, were determined at the same period of reflectance study. The spectral response was measured in 1100 hours, and normal to the ground surface, at a height of about 1m above the plant canopy. 5 spectral measurement were made for each treatment & basic data averaged. Irradiance of Ba So4, used for calibrating the percentage of reflection. Two types of indices viz. IR/R and

ND were generated using the reflectance of red and infra red region of the electromagnetic spectrum as explained by Ayyangar et al (1980).

PIGMENT STUDIES

The third leaf from the apex was used for the extraction of the pigments using 80% acetone. It was then centrifuged at 3000 rpm and the supernatant was used in the assay of chlorophyll 'a' chlorophyll 'b' and carotenoids following the method of Arnon (1949) and Maclachlan and Zalic (1963).

YIELD COMPONENTS

The date of flowering was recorded as the time required for 50% flowering. The ears were harvested after ripening, and the components of ear were analysed. The different components of reproductive parts such as Spike length, grith, floret numbers, grain numbers, and weight of grains per ear were observed. From these observation, the percentage of sterility, Biological index and Harvest index were computed as described by Donald and Hamblin (1976).