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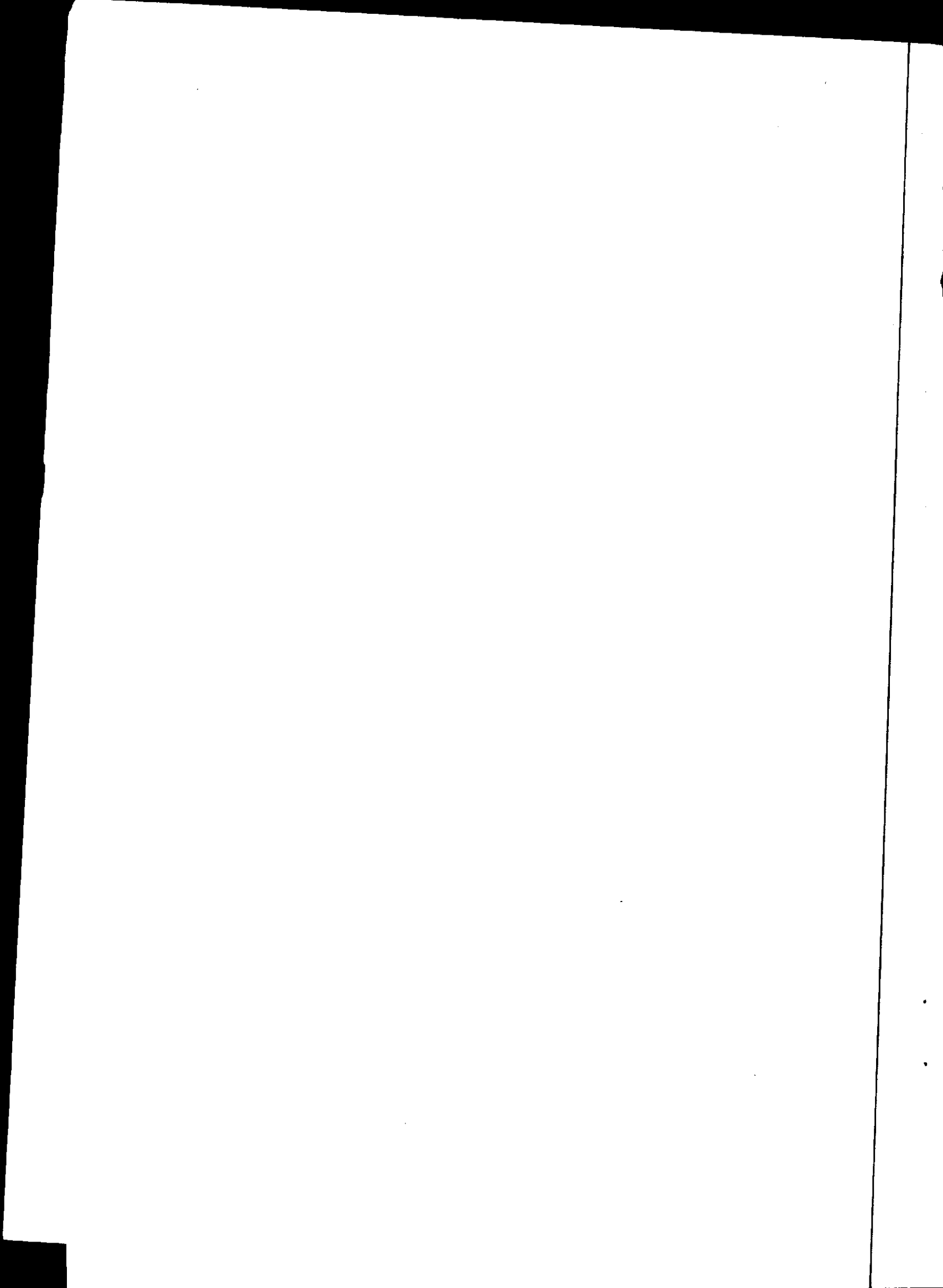
PROPOSAL FOR COLUMN EXPERIMENTS TO STUDY PHYSICAL AND  
CHEMICAL PROCESSES IN ACID SULFATE SOILS AT THE  
BARIF-INSTITUTE, BANJARBARU, SOUTH KALIMANTAN, INDONESIA

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## 1. INTRODUCTION

In order to study the basic physical and chemical processes in acid sulfate soils, a column experiment is planned. Within this experiment 7 undisturbed soil cores of 1 m length and 25 cm diameter, should be sampled in the field, brought into the laboratory, and subjected to various water management strategies.

The column experiments focus on the following processes:

- A. Total oxidation of pyrite and leaching of toxic elements.
- B. Minimum oxidation of pyrite and, if necessary, leaching of toxic elements.
- C. Reduction processes upon flooding.
- D. Leaching with brackish water.
- E. Upward transport of water and toxic elements.

At the start of the experiments, the initial properties of the columns should be determined. This includes physical properties, like moisture characteristics and (un)saturated hydraulic conductivity, and chemical properties like CEC, composition of the soil solution and mineral content of the soil ( $\text{FeS}_2$ ,  $\text{CaCO}_3$ , other iron minerals). Then the columns should be subjected to different water management strategies. The change in physical and chemical state within the soil columns should be monitored frequently, for instance once every two weeks. After one or two years (depending on the speed with which processes take place) the experiments should be concluded and the initial determinations repeated.

Because roots enhance water extraction from the soil, growing of crops on the columns would accelerate the physical processes and as a result, the chemical processes as well. The presence of crops however, also means that organic matter is added to the soil and that chemical components are extracted from the soil (solution), during the experiments. This hampers the monitoring of the complete chemical balance of the soil system. Also, measurement of the water balance of the soil by weighing the columns, is hampered by the production of plant material.

Therefore it is suggested to start the column experiments with bare soil and to continue these experiments for a certain period depending on the obtained interim results. After these period it can be decided to grow for instance a rice crop or purun grass on the different soil columns for the remaining time left.

## 2. SET-UP OF COLUMN EXPERIMENTS

### 2.1. Selection of columns

Two criteria will be applied to select columns for the proposed experiments. These criteria are:

- Depth of pyrite in soil profile.
- Water management strategy.

With respect to the depth of pyrite in the soil, two different profiles are selected:

1. A sulfidic clay. Pyrite in the upper 10 cm of the profile. pH 6-7, 10% organic matter, 60% clay. Under field circumstances almost saturated completely throughout the whole year.
2. A ripe acid sulfate clay (with raw subsoil). Pyrite from 40 downwards. pH around 4 or lower in the upper 40 cm. Approximately 10% organic matter and 60% clay. Under field circumstances groundwater-level not below 40 cm throughout the whole year.

The first soil type was chosen because it is best suitable for studying elementary processes in acid sulfate soil like oxidation of pyrite, leaching of toxic elements and oxidation of organic matter. The second profile was selected because it represents the most general type of acid sulfate soil in the study area. These type of acid sulfate soil with pyrite present at depths of about 40 cm and lower also covers large areas outside Indonesia. Furthermore, this soil profile offers the opportunity to grow paddy rice, provided that water management is aimed at high groundwater levels to minimize oxidation of pyrite.

## 2.2. Proposed water management strategies

The proposed water management strategies are:

### 1. Groundwater level constant at -80 cm, leaching with fresh water

At the start of the experiment, these columns should drain (drain open), and evaporate, until drain outflow stops. Drainoutflow should be monitored qualitatively and quantitatively.

When drainoutflow stops, the drain must be closed. Evaporation should continue for a few weeks until it becomes negligible.

Thereafter these columns should receive 100 mm of water. The drain should be opened and the drainoutflow should be monitored both quantitatively and qualitatively.

When drainoutflow stops, the drain should be closed and the experiment starts anew. The whole sequence: drying-leaching-drying-etc. should be repeated several times.

### 2. Groundwater level constant at -80 cm, leaching with brackish water

The same as 1., except with brackish water.

### 3. Groundwater level alternating between +5 and -80 cm

At the start of the experiment, these columns should drain (drain open), and evaporate, until drain outflow stops. Drainoutflow should be monitored qualitatively and quantitatively.

When drainoutflow stops, the drain must be closed. Evaporation should continue for a few weeks until it becomes negligible.

Thereafter these columns should receive daily 100 mm of water (drain closed). This is continued until the groundwater level has risen to + 5 cm.

The water level should be maintained at +5 cm for 4 weeks. If necessary, water should be supplied once a day. The amount should be recorded. After 4 weeks, the drain should be opened and the drainoutflow should be monitored both quantitatively and qualitatively.

When drainoutflow stops, the drain should be closed and the experiment starts anew. The whole sequence: drying-submergence-leaching-drying-submergence-etc. should be repeated several times.

#### 4. Groundwater level ranging from +5 to -10 cm

To start with, these columns should receive as much water to establish a ground water level of +5 cm.

The water level should be maintained at +5 cm for 4 weeks. If necessary, water should be supplied once a day. The amount should be recorded. After 4 weeks, water supply should be stopped. The columns will start to dry out by evaporation. Evaporation must be continued until the groundwater level has fallen down to -10 cm. At that moment, water should be supplied until the ground water level has risen to +5 cm again. This water level should be maintained again for 4 weeks. After 4 weeks, the second drying should take place, etc., etc. The sequence submergence-evaporation should be repeated several times. Thereafter, leaching can be applied by opening the drain until the groundwater level has fallen down to -10 cm.

The sequence submergence-drainage should also be repeated several times.

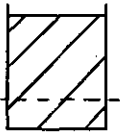
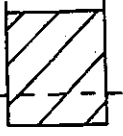
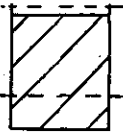
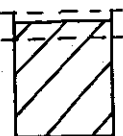
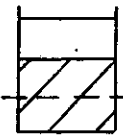
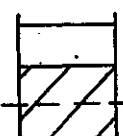
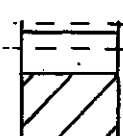
### 2.3. Outline of various column experiments

The 2 soil types and 4 different water management strategies offer the possibility to study all the processes of interest, mentioned in the introduction. In fact, 7 columns are considered to be sufficient. In table 1, these 7 proposed columns are pictured, together with the processes on which each individual column is focused.

Table 1. Water management strategies, soil types and processes under investigation of 7 column experiments.  
depth at which pyrite occurs.

----- range of groundwater level

Letters and numbers refer to the soil types, water management strategies and processes to be studied, as mentioned in the text

Column	Soil type	Water management	Processes to be studied
1. 	1. Sulfidic clay	1. Groundwater level at - 80 cm Leaching with fresh water	A and E Total oxidation of pyrite and leaching of toxic elements. Capillary rise of water and toxic elements
2. 	1. Sulfidic clay	2. Groundwater level at - 80 cm Leaching with brackish water	A, D and E Total oxidation of pyrite and leaching of toxic elements. Capillary rise of water and toxic elements. Leaching with brackish water
3. 	1. Sulfidic clay	3. Groundwater level alternatively at -80 and +5 cm, Leaching with fresh water	A, C and E Total oxidation of pyrite and leaching of toxic elements. Capillary rise of water and toxic elements. Reduction processes upon flooding
4. 	1. Sulfidic clay	4. Groundwater level alternatively at -10 and +5 cm, Leaching with fresh water	B and C Minimum oxidation of pyrite and, if necessary, leaching of toxic elements. Reduction processes upon flooding
5. 	2. Ripe acid sulfate soil	1. Groundwater level at - 80 cm Leaching with fresh water	A and E Total oxidation of pyrite and leaching of toxic elements. Capillary rise of water and toxic elements
6. 	2. Ripe acid sulfate soil	2. Groundwater level at - 80 cm Leaching with brackish water	A, D and E Total oxidation of pyrite and leaching of toxic elements. Capillary rise of water and toxic elements Leaching with brackish water
7. 	2. Ripe acid sulfate soil	4. Groundwater level alternatively at -10 and +5 cm, Leaching with fresh water	B and C Minimum oxidation of pyrite and, if necessary, leaching of toxic elements. Reduction processes upon flooding



### 3. MEASUREMENTS AND METHODS

#### 3.1. Measurements

In order to measure the effect of different watermanagement strategies on flow and moisture conditions in the different soil columns porous ceramic cups will be installed at different depths by which soil moisture suction and groundwater level can be monitored. Frequently soil moisture will be gathered with help of other porous polyethylen cups after which chemical composition can be determined in the laboratory. The first series of soil moisture determinations carried out after installation of the soil column in the laboratory will be assumed initials.

Further also some initial soil analysis will be carried out once on duplo, triple etc. soil samples taken in the direct neighbourhood of the sample location of the soil column. These analysis will be repeated with the soil column sample itself after the experiments have finished. The following determinations per layer or soil horizon will be carried out:

- initial measurements on duplo, triple etc. samples
 

soil moisture content	CEC size and occupation
organic matter content	humic and non-humic compounds
pF-curves	pyrite
k(h) relations	$\text{CaCO}_3/\text{CaSO}_4$
K-saturated	total (anorganic) sulfur
groundwaterlevel	total elemental composition
texture	with rontgendiffraction and/or
structure	rontgenfluorescence spectrometry
bulk density	micromorphology
- measurements during the experiments
 

in- and outgoing fluxes	chemical composition of incoming
column-weight	and outgoing water and soil
groundwaterlevel	moisture: $\text{Na}^+$ , $\text{K}^+$ , $\text{Mg}^{2+}$ , $\text{Ca}^{2+}$ ,
soil moisture suction	$\text{Mn}^{2+}$ , $\text{Fe}^{2+}$ , $\text{Al}^{3+}$ , $\text{Cl}^-$ , $\text{HCO}_3^-$ ,
partial $\text{O}_2$ pressure soil air	$(\text{SO}_4)^{2-}/\text{S}^{2-}$ , pH, dissolved oxygen
potential evapotranspiration	concentration, redoxpotential,
	electroconductivity

## - final measurements

soil moisture content	CEC size and occupation
organic matter content	humic and non-humic compounds
groundwaterlevel	pyrite
structure	CaCO <sub>3</sub> /CaSO <sub>4</sub>
	total (anorganic) sulfur
	total elemental composition
	with rontgendiffraction and/or
	rontgenfluorescence spectrometry

## 3.2. Methods

## 3.2.1. Taking of undisturbed columns in the field

7 Undisturbed colums shall be taken with the universal hydraulic soil sampling kit of Eijkelkamp B.V..

## 3.2.2. Installation and instrumentation of soil columns in the laboratory

The soil columns should be brought into the laboratory. The whole column should be weighed regularly, using a moveable balance (fig. 1). In the soil column, tensiometer cups will be installed at 2, 5, 10, 30, 60, 90 cm depth. A small diameter groundwater level tube will be installed as well. Each individual column should be placed on a 20 cm high sand bed, with a drainage system in it. The drainage system must have a tap to adjust or stop drain outflow.

Besides the tensiometer cups for measuring moisture suction, porous polyethyleen cups will be installed at different depths in the soil columns in order to make collection of soil moisture for chemical analysis possible.

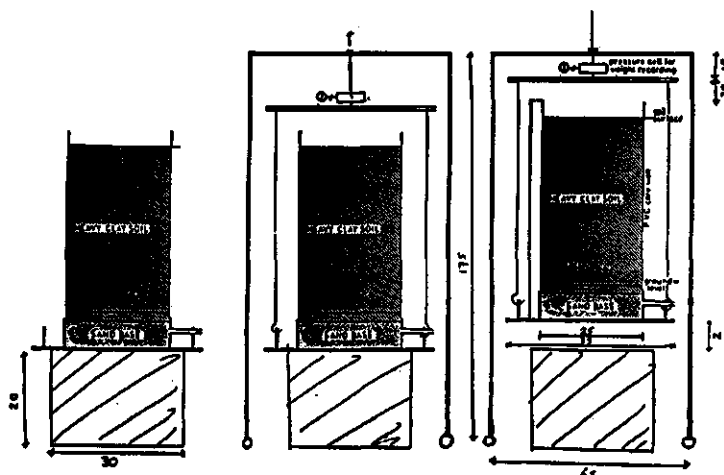


Fig. 1. Moveable balance for weighing the different soil columns during the experiments in the laboratory. (All sizes in cm)

### 3.2.3. Methods for physical measurements during experiments

Soil physical measurements include initial measurement of soil physical properties, together with continuous measurements of soil physical processes during the experiments.

The water retention curves and the unsaturated hydraulic conductivity of the various soil layers will be determined by the evaporation method of WIND (1969).

Saturated hydraulic conductivity will be determined in the field and in the laboratory on large cores.

Pressure heads will be measured using tensiometers.

Potential evaporation will be determined with small water reservoirs in between of the soil columns.

## 3.2.4. Methods for chemical measurements during experiments

Chemical analysis on duplo, triple etc. soil samples will be carried out in the Netherlands with the following laboratory methods:

CEC	Ag-thio-ureum method
humic, non-humic compounds	determination of oxygen demand
pyrite	microscopic, chemical and/or with rontgen-diffraction/rontgenfluorescence spectrometry
other (iron) minerals	rontgendiffraction/rontgenfluorescence spectrometry
micromorphology	Impregnated thin sections

These determinations will also be carried out on the soil column samples after finishing the experiments.

Water extracted from porous polyethylen cups, free water standing on the soil surface, irrigation water and drain outflow should be sampled regularly. In these samples, several elements should be determined, besides some basic measurements. Basic measurements will be carried out with:

pH	pH-meter
electroconductivity	EC-meter
dissolved O <sub>2</sub> conc.	dissolved oxygen meter
partial O <sub>2</sub> pressure	electrodes
redoxpotential	redoxelectrodes

For determination of the different elements the following laboratory methods will be used:

Na <sup>+</sup> and K <sup>+</sup>	flame photometer
Mg <sup>2+</sup> and Ca <sup>2+</sup>	atomic absorption spectrophotometer
Fe <sup>2+</sup> and Mn <sup>2+</sup>	atomic absorption spectrophotometer
Al <sup>3+</sup>	spectrophotometer
Cl <sup>-</sup>	titrimetric
(SO <sub>4</sub> ) <sup>2-</sup>	spectrophotometer
HCO <sub>3</sub> <sup>-</sup>	titrimetric

For various of the above mentioned elements alternative determination methods are available in case an apparatus break down:

Na <sup>+</sup> and K <sup>+</sup>	atomic absorption spectrophotometer
Mg <sup>2+</sup> and Ca <sup>2+</sup>	titrimetric
Fe <sup>2+</sup> and Mn <sup>2+</sup>	spectrophotometer
Al <sup>3+</sup>	atomic absorption spectrophotometer (if nitrousoxate is available)
Cl <sup>-</sup>	-
(SO <sub>4</sub> ) <sup>2-</sup>	-
HCO <sub>3</sub>	-

The sampling intensity during the experiments depends amongst others on the total time necessary to execute all laboratory determinations. Based on an amount of approximately 60 determinations (2 samples, one of fresh and one of brackish water to be added to the soil columns; maximum 3 samples of standing water on top of the soil columns; 7 columns, each with 5 porous cups gives another 35 water samples; 7 drainage water samples; and several samples for duplo or triple control measurements) the following time-schedule for the laboratory work, is assumed rather realistic:

Na <sup>+</sup> and K <sup>+</sup>	1.0 day
Mg <sup>2+</sup> and Ca <sup>2+</sup>	1.0 day
Fe <sup>2+</sup> and Mn <sup>2+</sup>	1.0 day
Al <sup>3+</sup>	2.0 day
Cl <sup>-</sup>	1.0 day
(SO <sub>2</sub> ) <sup>2-</sup>	2.0 day
H <sub>2</sub> CO <sub>3</sub> /HCO <sub>3</sub> <sup>-</sup> and pH	1.0 day
partial O <sub>2</sub> pressure	0.5 day
redoxpotential	0.5 day +
<b>total</b>	<b>10.0 days</b>

This leads to the conclusion that it takes approximately 10 days for one person to carry out all planned soil water determinations. During the experiments sampling frequency of once every two weeks should be aimed at. According to LE NGOC SEN (1988) a frequency between once every two weeks and once every four weeks is high enough to monitor

chemical changes in the soil moisture of acid sulfate soils exposed to different watermanagement strategies (in lysimeter or column experiments) accurately. If during the experiments it becomes clear that the chemical composition of the soil moisture do change slow it can be decided to sample soil moisture once every three or four weeks.

## 4. TIME SCHEDULE

In order to prevent indistinctness about the various running and forthcoming activities within the acid sulfate soil project a chronological list is presented for the ICW modelling component up to october 1988. In most of the mentioned activities several persons are involved, sometimes for only a short period. It is because of this that also a (rough) time schedule for participants is presented.

october 1987 \* starting of project.

- \* literature review and first simple calculations on oxidation of pyrite and oxygen diffusion in soil resulting in ICW Nota 1821:

"Analysis of important parameters and first outline of simulation model", pp.66

november 1987 \* introductory mission to Indonesia resulting in ICW Nota 1819:

"Report of an introductory mission to the counterpart institutes CSR-Bogor and BARIF-Banjarbaru and the tidal swamp area of Pulau Petak, South Kalimantan, Indonesia", pp.18

- \* preliminary work on column experiments, selection of columns, description of water management strategies, measurements, methods and materials and enumeration of materials required for the various experiments

december 1987 resulting in ICW Nota 18..:

"Column experiments for studying physical and chemical processes in acid sulfate soils", pp..

- \* placing orders in Indonesia and the Netherlands for materials for column experiments

- \* regularly deliberation with STIBOKA and ILRI counterparts

- january,           \* introductory laboratory work with associate expert  
february and       Drs. C. Konsten  
march 1988       \* arrival CSR-counterpart in modelling, Ir. Kusumo  
                  Nugroho, in the Netherlands
- \* introduction Ir. Nugroho in ICW institute and especially in ICW modelling component
  - \* placing orders in Indonesia and the Netherlands for materials for column experiments
  - \* regularly deliberation with STIBOKA and ILRI counterparts
  - \* inventarisation of ICW models/submodels possible useful for (partly) incorporation in future 'acid sulfate soil model'
  - \* further development of proposed 'acid sulfate soil model'
  - \* appointment of two laboratory assistants
  - \* selection of acid sulfate soils in the Netherlands to be used for similar column experiments as those in Indonesia
  - \* gathering of soil columns in the field and starting up experiments in the ICW-laboratory
  - \* getting familiar with laboratory measurements/determinations, possibilities and unpossibilities, interpretation of interim results and accuracies
  - \* one month mission (march) of A. van den Toorn to BARIF, Banjarbaru, to install/operationalize all necessary laboratory equipment delivered by US-AID (if available in time) and/or bought by LAWOO acid sulfate soil project. First training of laboratory personnel in operating equipment
  - \* design of sheets and/or computer data base for writing down or storing laboratory results (to be used in the Netherlands and Indonesia)
  - \* dependent on gained experience, adjustment of proposed column experiments in Indonesia



- april 1988 \* mission of Bronswijk and Ritsema to Indonesia for collecting undisturbed soil columns, starting up laboratory facilities and guiding the first measurements
- \* carry out standard measurements/determinations by local team
- may 1988 \* sending of duplo, triple etc. soil samples to the Netherlands for complicated initial soil analysis
- \* writing of mission report, resulting in ICW-Nota  
.....: "Report of ....."  
....."
- june 1988 \* determination of duplo, triple etc. soil samples in ICW laboratory by engaged laboratory assistants (special determinations will be partly board out, for instance rontgendiffraction and/or rontgenfluorescence spectrometry)
- \* continuation of the development of the 'acid sulfate soil' model
- july 1988 \* interpretation of first interim results of column experiments carried out in Indonesia and the Netherlands
- \* possibly adjustment of measurement program for column experiments
- august 1988 \* preliminary work on lysimeter experiments, selection of suitable fields, description of water management strategies, measurements, methods and materials and enumeration of materials required for the various experiments
- \* ordering materials for installation and set-up of lysimeter experiments
- september 1988 \* mission of J. Harmsen to BARIF, Banjarbaru, in order to give a training course in laboratory practises for the Indonesian analysts and controlling of measurements
- \* mission to Indonesia for installing lysimeters in fields (fields probably also in use by participants of the ILRI-component),

october 1988 \* resulting in ICW-Nota .....: "Mission report of .....  
 ....."  
 \* continuation of the development of the 'acid sulfate  
 soil' model

	1987			1988												
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Van Wijk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoeks/Roest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bronswijk	-----															
Ritsema	-----															
Nugroho	-----															
lab assistants ICW	-----															
Konsten + CSR-counterpart	-----															
Ind. assistants (BARIF)	-----															
Van den Toorn	-----															
Harmsen	-----															

Bronswijk and Ritsema will be involved in most of the above mentioned activities.

Nugroho will be involved in modelling physical and chemical processes in acid sulfate soils up from the end of january 1988.

Harmsen/Van den Toorn will train the associate expert and other members of the modelling team in laboratory techniques during one week in january 1988. Moreover they assist in inventorying/ordering of equipment, materials and chemicals needed at the BARIF laboratory.

The dutch laboratory assistants will carry out most of the field and attendant laboratory work in the Netherlands.

Starting half of april, the associate expert, Konsten will be partly involved in the ICW and STIBOKA component. In the first period she will spend two days per week for the ICW modelling component. Later on this will be enlarged up to full time.

The Indonesian assistants will join in the gathering of field soil columns in the period half of april up to probably half of may. From then on they will carry out the measurement program in the laboratory under scientific guidance of Konsten and her CSR-counterpart.

Van den Toorn will start up the laboratory itself in the month march. Later that year Harmsen will bring another visit for giving a training course in laboratory practises for the Indonesian analysts and controlling of measurements.

LITERATURE

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## INDONESIAN SUMMARY - RINGKASAN

## PERCOBAAN DENGAN MENGGUNAKAN KOLOM BERBENTUK SILINDER

Percobaan ini dilakukan dengan menggunakan kolom berbentuk silinder yang terbuat dari PVC. Percobaan ini dimaksudkan untuk mempelajari beberapa proses kimia dan fisik tanah sulfat masam di laboratorium Balittan Banjar Baru Kalimantan Selatan Indonesia.

## I. BAHAN

7 contoh tanah berupa kolom silinder berukuran panjang 1 m dan diameter 25 cm, diambil dari lapang dan dibawa ke laboratorium. Kolom ini akan diberi perlakuan tertentu.

## II. PROSES YANG AKAN DITELITI PADA PERCOBAAN INI

- A. Oksidasi secara keseluruhan, pyrit dan pencucian unsur-unsur beracun.
- B. Oksidasi minimum pyrit, dan jika ada pun pencucian unsur-unsur beracun.
- C. Proses reduksi selama terdapat banjir/dibanjiri.
- D. Pencucian oleh air payau.
- E. Gerak air dan unsur-unsur beracun keatas permukaan.

## III. TAHAP PERCOBAAN

Tahap 1. Penetapan sifat kimia dan fisik tanah pda saat awal.

(sifat fisik: kelembaban, hidrolik konduktivitas jenuh dan tidak jenuh; sifat kimia : KTK, komposisi unsur-unsur, kandungan mineral  $\text{FeS}_2$ ,  $\text{CaCO}_3$ , dan mineral lain)

Tahap 2. Perlakuan pengelolaan air

Tahap 3. Pengamatan perubahan sifat tanah (tiap minggu- 2 tahun; tergantung kecepatan proses)

Tahap 4. Perlakuan memberikan hasil, dilakukan penetapan sifat kimia dan fisik seperti pada awal percobaan.

## IV. BEBERAPA MASALAH

- rumput atau tanaman akan:
  - \* mempercepat proses kimia dan fisik
  - \* menambah bahan organik
  - \* munculnya ekstraksi berbagai unsur kimia
- masalah ini diharapkan dapat dilihat dengan selalu menimbang berat kolom, meneliti percobaan ini dengan tanaman padi atau rumput purun serta membandingkannya bila tanpa tanaman.

## V. CONTOH TANAH UNTUK PERCOBAAN DIBEDAKAN MENURUT

- kedalaman pirit dalam kolom/profil
- perlakuan pengelolaan air

## V.1. Type atau Jenis tanah menurut kriteria pertama

1. liat bahan sulfidik. Pirit di kedalaman 10 cm pH 6.7 Bahan Organik 10%, liat 60%, hampir jenuh sepanjang tahun
2. liat sulfat masam, matang dengan lapisan bawah yang masih mentah. pirit dari kedalaman 40 cm ke bawah. Bahan organik  $\pm$  10%, liat 60% kedalaman air tanah lebih dari 40 cm sepanjang tahun.

Skema pengambilan contoh tanah dan proses yang dipelajari

Type tanah	perlakuan pengelolaan air			
	tetap. 80 cm tawar a	tetap. 80 cm payau b	berfluktuasi 5-80 cm. tawar c	berfluktuasi 5-10 cm. tawar d
1	A E	A E D	A E C	B C
2	A E	A E D		B C

Angka pada type tanah seperti pada kriteria yang dikemukakan dia atas (pada bagian V).

Huruf besar pada perlakuan pengelolaan air mendapat proses seperti pada II.

## V.2. Cara pengelolaan air

- a. Tinggi muka air konstan -80 cm, tambahan air tawar. Mula-mula muka air tanah diturunkan (didrainasi), air yang dikeluarkan diamati secara kuantitatif dan kualitatif. Kolom ini menerima air sejumlah tertentu tiap hari, tergantung penelitian dan evaporasi. Jika muka air tanah lebih 70 cm, pemberian air dihentikan.
- b. sama dengan a, tetapi air yang diberikan air payau.
- c. Muka air tanah berfluktuasi 5-80 cm, air yang diberikan air tawar.
- d. Muka air tanah berfluktuasi 5-10 cm, air yang diberikan air tawar.

## VI. PENGUKURAN

Kelembaban, serta alur air ditentukan dengan menggunakan alat berupa tabung plastik sarang, dan dihisap oleh alat TENSIOMETER TFDL. Larutan atau cairan yang dihisap akan dianalisa di laboratorium.

### VI.1. Jenis analisa

Analisa pendahuluan ( duplo atau triplo.)

- |                                |                                 |
|--------------------------------|---------------------------------|
| 1. Kadar air tanah             | KTK, ukuran dan jangkuan bidang |
| 2. Kandungan Bahan organik     | Senyawa humik dan non humik     |
| 3. Tegangan air                | Pyrit                           |
| 4. Hubungan K(h)               | $\text{CaCO}_3/\text{CaSO}_4$   |
| 5. K jenuh                     | total S inorganik               |
| 6. muka air tanah              | komposisi unsur-unsur           |
| 7. tekstur                     | difraksi rontgen/spektrometri   |
| 8. struktur                    |                                 |
| 9. kerapatan jenis/lindak (BD) |                                 |

Analisa pada waktu percobaan

- |                                    |   |
|------------------------------------|---|
| 1. Aliran masuk dan keluar kolom   | analisa kimia cairan dari tabung  |
| 2. Berat kolom                     | $\text{Na}^+$ , $\text{K}^+$ , $\text{Mg}^{2+}$ , $\text{Ca}^{2+}$ , $\text{Mn}^{2+}$ , $\text{Fe}^{2+}$ ,<br>$\text{Al}^{3+}$ , $\text{Cl}^-$ , $\text{HCO}_3^-$ , $(\text{SO}_4)^{2-}$ ,<br>$\text{S}^{2-}$ , pH, konsentrasi oksigen terlarut, |
| 3. tinggi muka air tanah           |   |
| 4. tekanan udara oleh $\text{O}_2$ | redox potential, EC   |
| 5. Evapotranspirasi potential      |   |

Analisa pada akhir perlakuan

- |                            |  |
|----------------------------|--|
| 1. Kadar air tanah         | KTK  |
| 2. Kandungan bahan organik | Senyawa Humik dan non Humik                          |
| 3. Tinggi muka air tanah   | pirit, $\text{CaCO}_3$ , $\text{CaSO}_4$ , total S   |
| 4. Struktur                | komposisi unsur<br>difraksi rontgen dan spectrometri |

#### VI.2. Cara pengambilan contoh untuk analisa fisika

Cara pengangkatan tanah dengan alat dari Eijkelkamp BV.

#### VI.3. Cara perakitan/penempatan contoh kolom di laboratorium

- dilakukan dengan menggunakan air conditioning, untuk menjaga agar fluktuasi suhu dapat dikontrol.
- berat kolom model selalu dikontrol dengan menimbang (dengan timbangan yang dapat bergerak)
- didalam kolom model tabung tensiometer dipasang pada kedalaman 2, 5, 10, 30, 60, 90 cm dari permukaan.
- tabung pengukur tinggi muka air tanah dipasang
- tiap kolom dipasang pada lapisan pasir setebal 20 cm dengan sistim kran yang mengatur keluarnya air.
- selain tabung potensimeter juga dipasang tabung polyethylene pada berbagai kedalaman.

#### VI.4. Metoda pengukuran sifat fisik tanah

Pengukuran berlaku untuk pengamatan awal, pada waktu percobaan dan akhir percobaan. Kurva Tegangan air dan daya hantar air (hidrolic conductivity) tidak jenuh ditentukan dengan cara evaporasi WIND (1969) HC jenuh ditentukan di lapang dan laboratorium. Tekanan atas akan diukur dengan tensiometer. Evaporasi potensial diukur dengan wadah air diantara kolom tanah.

## VI.5. Metoda pengukuran sifat kimia

Pengukuran duplo atau triplo, dilakukan di Belanda meliputi:

KTK	Cara Ag-thio-ureum
senyawa humic, nonhumik	ditetapkan melalui kebutuhan oksigen
pirit atau mineral lain	mikroskopis, kimia, difraksi/fluorescen
(besi)	Rontgen spectrometri
mikromorphologi	impregnansi irisan

Penetapan ini juga dilakukan untuk contoh kolom setelah percobaan selesai.

Contoh air/larutan yang tercakup dalam percobaan ini dianalisa dengan:

Jenis analisa	Cara I	Cara II	lama hari
pH	pH meter		
daya hantar listrik	EC meter		
O <sub>2</sub> terlarut	diss.O <sub>2</sub> meter		
tekanan O <sub>2</sub> bagian	electroda		0.5
redoks potensial	redokselektroda		0.5
Na <sup>+</sup> dan K <sup>+</sup>	flamephotometer	AAS	1
Mg <sup>2+</sup> dan Ca <sup>2+</sup>	AAS	titrimetri	1
Fe <sup>2+</sup> dan Mn <sup>2+</sup>	AAS	spectrophotometer	1
Al <sup>3+</sup>	spectrophotometer	AAS (jika nitrous-oxate ada)	2
Cl <sup>-</sup>	titrimetri	-	1
(SO <sub>4</sub> ) <sup>2-</sup>	spektrophotometer	-	2
HCO <sub>3</sub> <sup>-</sup>	titrimetri	-	1

Intensitas tergantung dari waktu untuk analisa/penetapan unsur lain. Lama analisa seperti tercantum dalam tabel diatas, didasarkan asumsi 60 penetapan (2 contoh air tawar+payau yang ditambahkan ke kolom, 3 contoh air genangan, 7 kolom x 5 tabung = 35 contoh air, 7 air drainasi dan contoh duplo/triplonya). Dengan asumsi tersebut diperkirakan pengamatan setiap 2 minggu, diharapkan dapat dilakukan dan cukup intensif. Jika perubahan tidak terlalu banyak maka dapat dilakukan setiap 3/4 minggu sekali.