

# ***Acid Sulfate Soils***



**Presentation**  
**By Narioka, H.**

***Acid Sulfate Soil in rice production for  
Negara Brunei Darussalam***

***in 2011***

# Acid Sulfate Soil in rice production for Negara Brunei Darussalam

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## Problem Recognition and Problem Soils



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# *Study*





جايتن قرتانين دان اكري ماكنن  
JABATAN PERTANIAN DAN AGRIMAKANAN  
KEMENTERIAN PERINDUSTRIAN DAN SUMBER - SUMBER UTAMA BRUNEI DARUSSALAM



DEPARTMENT OF AGRICULTURE AND AGRIFOOD  
Ministry of Industry and Primary Resources  
Brunei Darussalam



A.S.S. team





**A.S.S. field**





**A.S.S. field**





**Setting of groundwater observation system**





**Setting of groundwater observation system**





**Setting of groundwater observation system**





**Pond which was affected excessively of A.S.S.**





**Jarosite and crack on the surface at rice field**





**Jarosite and crack on the surface of rice field**







# Training items (at field investigation)

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- 1) **"Safety First"**
- 2) Existence of ASS by **"watch, hear, smell, touch, think"**
- 3) Mechanism of ASS
- 4) Rice field structure
- 5) Role and importance of irrigation and drainage
- 6) **Field investigation method**
- 7) Experienced soil layer structure of rice field
- 8) Thought about **"improvement of ASS problem"**
- 9) **"The Team-work"** and each confidence

# ***What is the problem (soil)?***







# What is the problem (soil)?

## —Poor Soils

Poor soils refer to low potential soil productivity. Potential soil productivity is the maximum productivity shown by soil that is optimum in factors for biological production, including drainage, inclination conditions, and their combination

## —Problem Soils

There are a variety of soils; some soils have serious problems when utilized.

These soils are less productive and unsuitable even for the growth of crops because of the presence of extremely specific chemical, physical and biological properties.

Typical problem soils are peat soil, saline soils alkaline soils and acid sulfate soils.

Globally, Vertisol, Planosol, heavy clay alluvial soil, as well as strong weathering soil in the tropical zone are also considered to be problem soils.

# Important information for research: "Topology and Soil Profiles"







# Topology

Important information

- Natural resources
- Land use
- Topology
- Field (*in situ*)
- Environment





# Soils

## Important items

- Poor Soils
- Problem Soils

## Exercise

- Saline Soil
- **Acid Sulfate Soil**
- Peat Soil
- Vertisols



# Soil Profiles



I

Peat Soil

II

Saline Soil  
in the wood area

III

Saline Soil  
in the hazard area

IV

Acid Sulfate Soil

# Case of Problem Soils

- Acid Sulfate Soils
- Saline Soils
- Vertisols







# Acid Sulfate Soils

## Case of Problem Soils

Acid sulfate soils are covered 43.6% of Africa, 38.2% of Southeast Asia and 16.6% of South Asia. The area of acid sulfate soils reaches about 12 million hectares worldwide, most of which is located in tropical mangroves in Africa and Southeast Asia. The acid sulfate soils zone in Southeast Asia is considered to be potential farmland, but is not farmed because of its strong acidity.

Acid sulfate soils oxidizes when sulfate oxides in the soil are supplied oxygen due to land draining, leading to the formation of sulfuric acid and subsequent strong acidification of the soil to pH 3 or lower.



# Saline Soils

## Case of Problem Soils



Saline soils are distributed in the semi-arid, arid, coastal and poor-draining zones in the world.

Definition by the U.S. Department of Agriculture (USDA):

- Electric Conductivity ( $EC_{sat}$ ; saturated extract)  $\geq 4 \text{ mS/cm}$
- Exchangeable Sodium Percentage (ESP)  $< 15\%$
- $pH < 8.5$



# Vertisols

## Case of Problem Soils

Black Cotton Soil (Africa and India), Regur (India), Gray and Brown Soils of Heavy Texture (Australia) etc.

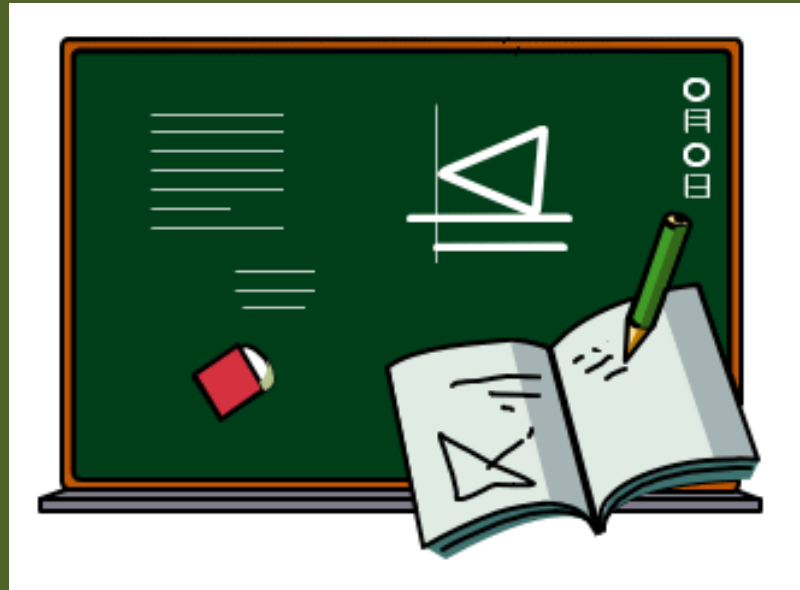
This requires material with a high shrink-swell potential plus alternate wetting and drying.

Vertisols are very slowly permeable, once the cracks swell shut, and slow infiltration is a problem in irrigation.

They have a low plant-available water-holding capacity, but a relatively high total water-holding capacity. Because of their low permeability, once they have wet-up, Vertisols are good for paddy (wet) rice culture, because entrapped (diked) water does not leak away.



# ***Strategies***







# Strategy (1)

(Important information and items are understood and developed into the strategy)

- Investigation/Research
- Administration  
(government policy)
- Civilian Activity  
(civilian productivity)
- Living Persons  
(human life)





## Strategy (2)

1. Time scale and spatial scale
2. Topological information (landform, coastline and water boundary)
3. Policy in the country (viewpoint to the problem)
4. Meaning of "Development, Protection and Conservation"





# Strategy (3)

(The necessary information)

- Map (soil, soil profiles, land use, vegetation, topological, etc.)
- Remote sensing, GIS etc.
- Soil researcher
- Professional of the Soil Investigation
- Soil Science
- Soil Conservation
- Consideration of "Development, Protection and Conservation"

# ***Plan Formulation for Improvement / Conservation***







# Procedure for approaching

1. **Policy** (viewpoint to the problem)
2. **Time scale and spatial scale**
3. **Land resources** (landform, coastline and water boundary)





# Necessary information (1)

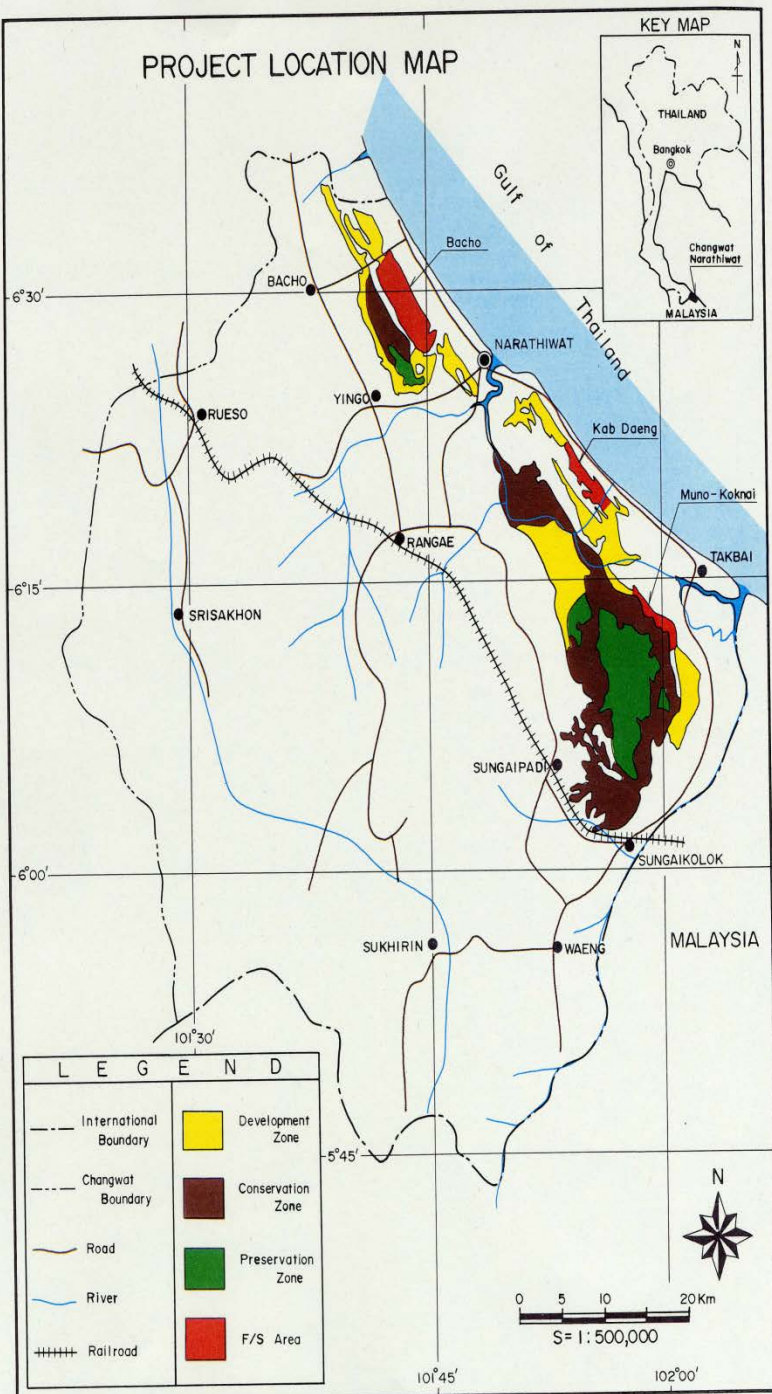
- **Map** (soil, soil profiles, land use, vegetation, topological, etc.)
- **Remote sensing, GIS etc.**





## Necessary information (2)

- Soil researcher
- Soil investigator
- Soil scientist
- Engineer
- Designer



# Research for land use

## 1. Check point

(1) Soil properties

(2) Water condition

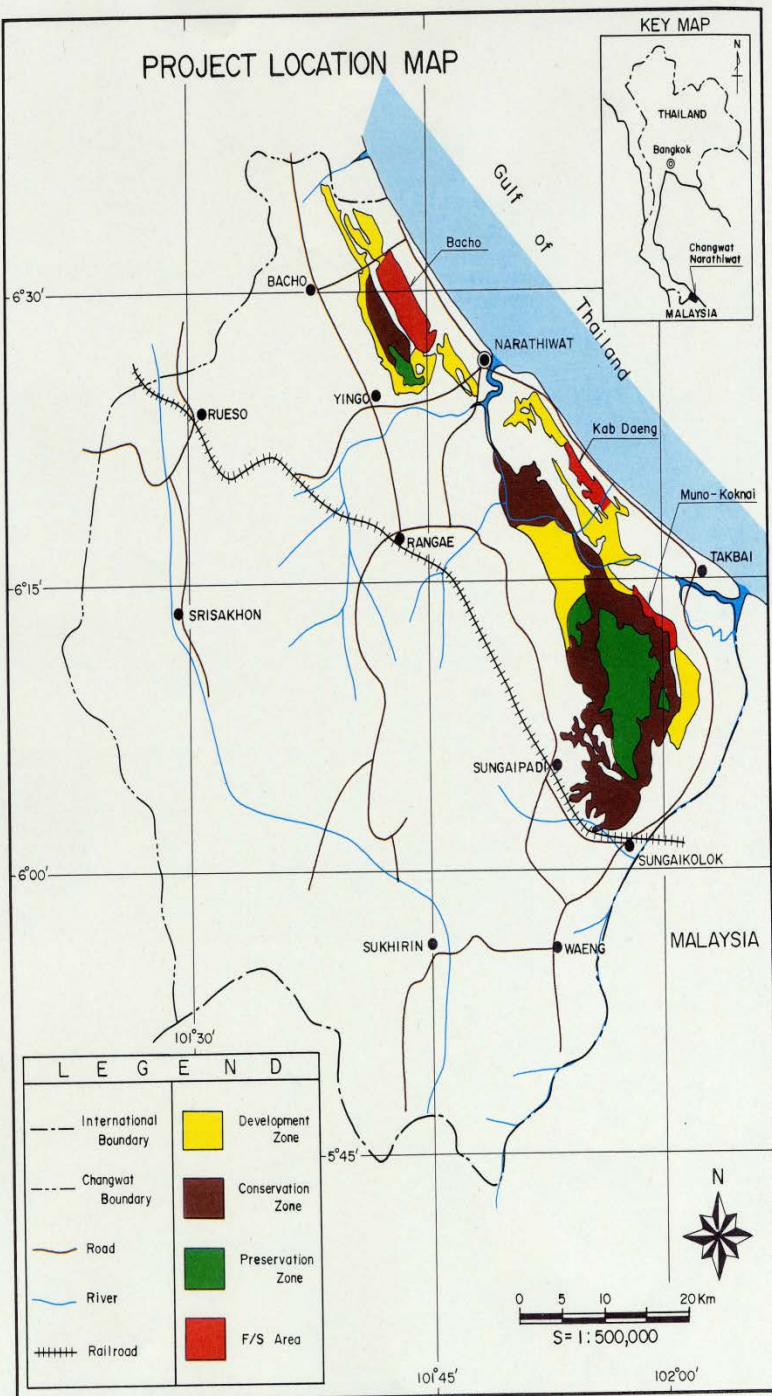
(3) Land classification in consideration of topography and social

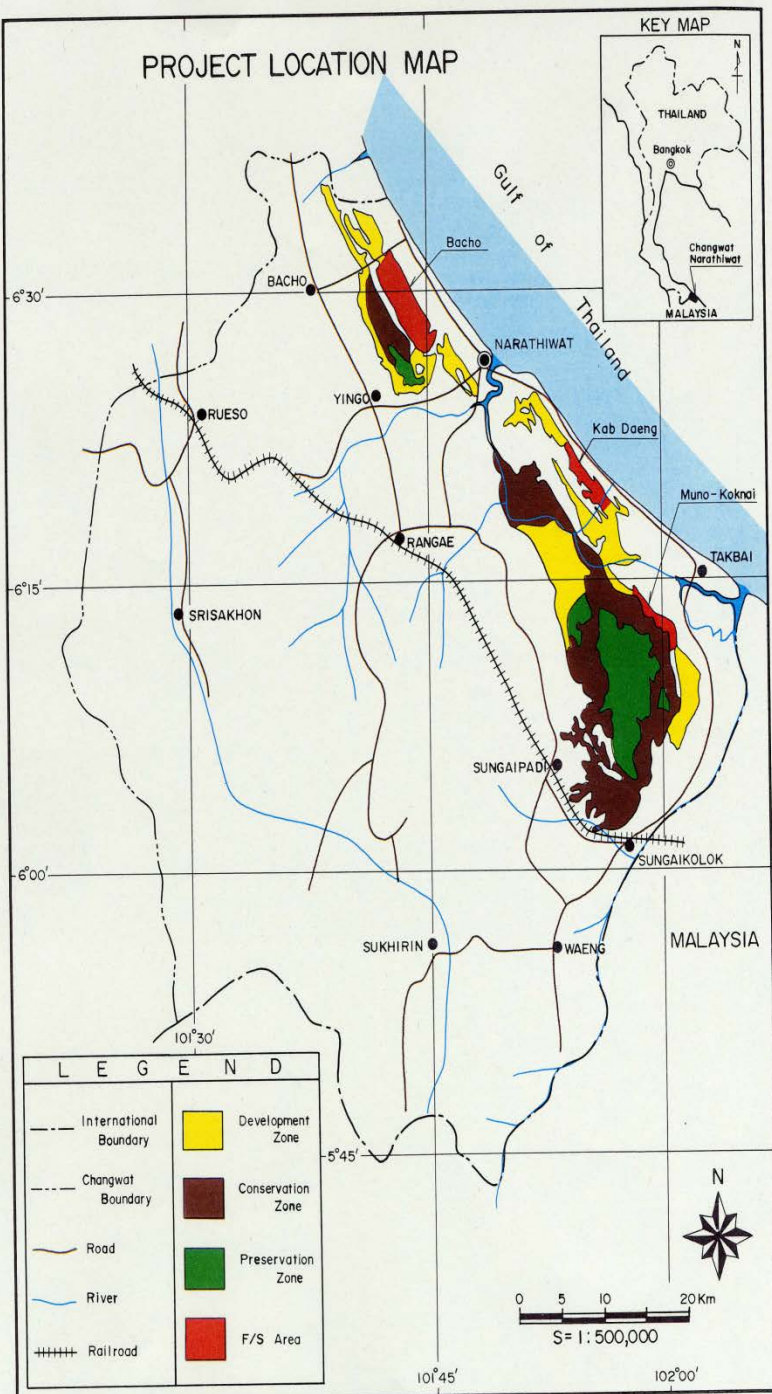


# Research for land use

## 2. Strategies

- Drainage and dry field farming by **control of groundwater**
- Rice field production by **irrigation and flood control**
- Mixed cultivation** by control of groundwater level
- Land condition which **pyrite** is oxidized or not
- Local community in regional **participation**
- others





# Research for land use

## 3. OK? or NG? Development, Conservation, Protection

✳️ Estimation is not easy for "Peat Soil and Acid Sulfate Soil"

✳️ Mechanism in the field of Acid Sulfate Soil is unexplained



# ***Acid Sulfate Soils***

## ***Process and Strategy***



# Reports



Soil Fertility Evaluation/Advisory Service in Negara Brunei Darussalam

Volume 1

Soils and Land Suitability  
of the  
Agricultural Development Areas

Contract: LTN/6/31/2003(10)



CSIRO Land and Water  
2008

Department of Agriculture  
Brunei Darussalam

1) Department of Agriculture(2008):  
Soils and Land Suitability of the  
Agricultural Development Areas,  
Soil Fertility Evaluation/Advisory  
Service in Negara Brunei  
Darussalam Volume 1, Contract:  
LTN/6/31/2003(10)

2) Department of Agriculture(2008):  
Soil Management in the  
Agricultural Development Areas,  
Soil Fertility Evaluation/Advisory  
Service in Negara Brunei  
Darussalam Volume 2, Contract:  
LTN/6/31/2003(10)



# Soil Profiles



I

Peat Soil

II

Saline Soil  
in the wood area

III

Saline Soil  
in the hazard area

IV

Acid Sulfate Soil

# *What is “ASS” ?*



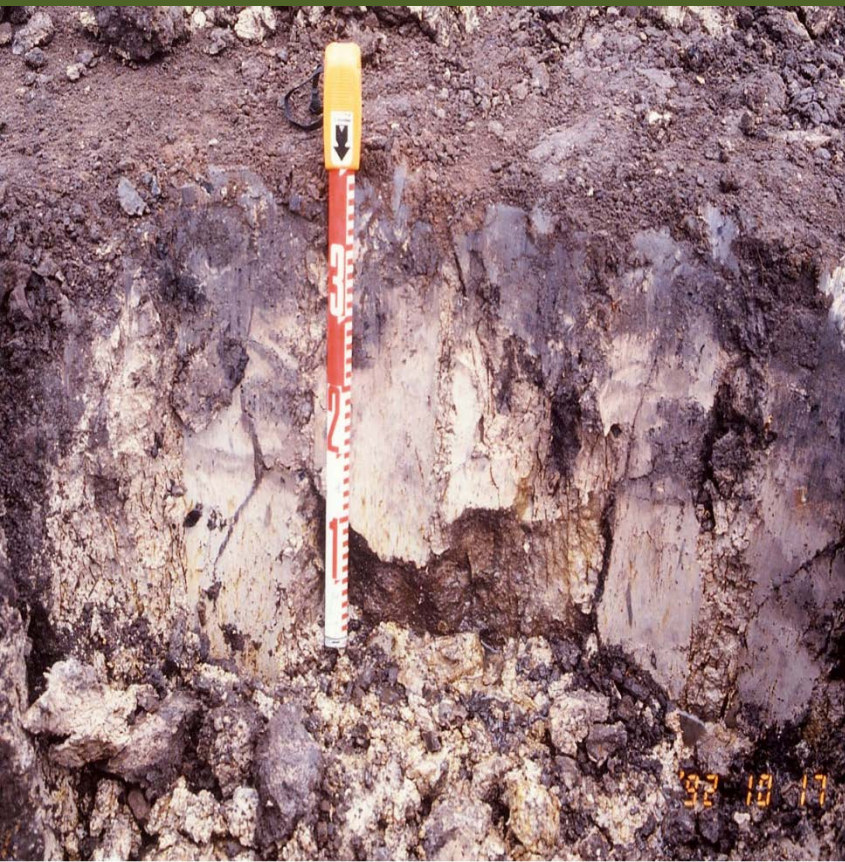


# Acid Sulfate Soil

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## Characteristics

- (1) Strong acidity (pH3)
- (2) Oxidation of deposition below water surface or mud (local lake or sea)
- (3) These are called “Acid Sulfate Soil” (ASS) by origin material
- (4) There is easy to be ASS in the Geologic period







# **Mangrove area**

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- ※ **ASS in the world is distributed around 12,000,000ha.**
- ※ **Most of ASS area is in Mangrove area.**
- ※ **ASS area in Southeast Asia is “Potential farmland” .**



# Mechanism of A.S.S.





# Why is “A.S.S.”

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**Generation of Acid Soil  
has two process.**

**(1) Accumulation process  
of sulfide**

**(2) Sulfuric acid process  
by oxidation.**

**→Physical, Chemical  
and Biological  
process**





# **Accumulation process of sulfide(1)**

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**Process:**

**Marine and Volcanic**

**Original materials:**

**Pyrite( $\text{FeS}_2$ )**





# Sulfuric acid process by oxidation(2)

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※ Oxidation of Sulfide  
 $\leq \text{pH}3$

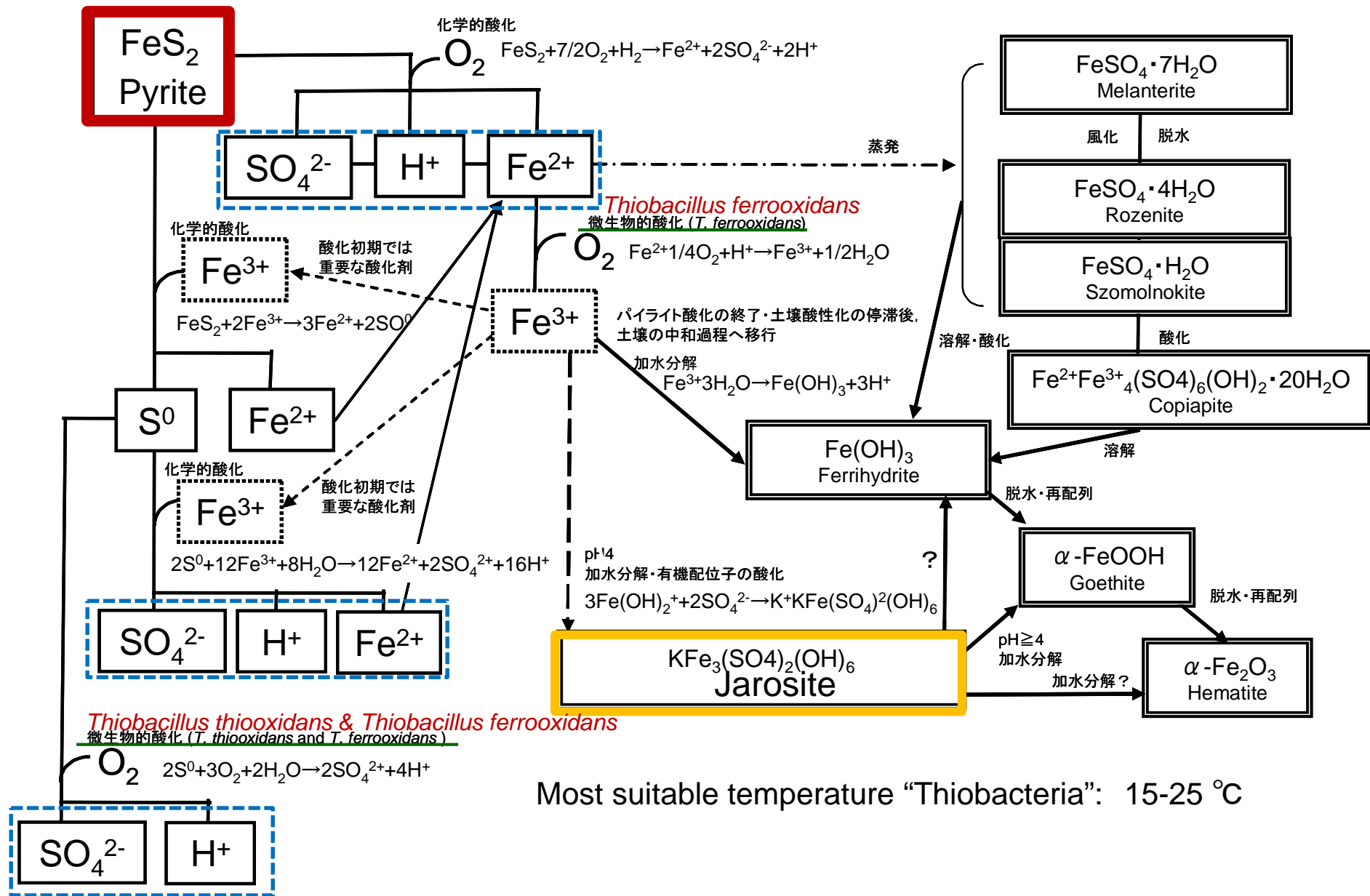


※ Generation of  
Sulfuric Acid



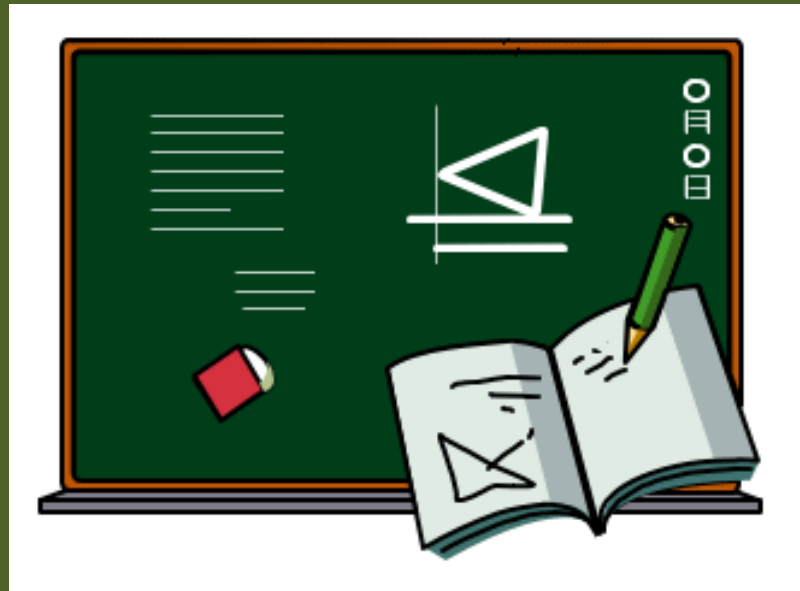
※ **Pyrite( $\text{FeS}_2$ )**  
Chemical and Biological  
Oxidation





# Process of Oxidation

# *Field of A.S.S.*





# **Southeast Asia: Peat soil and A.S.S.**

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- 1. Peat soil, flooding and shallow groundwater level**
- 2. Natural environments (groundwater, soil and wildlife etc.)**
- 3. Local economy and social**
- 4. Farmland development (suitable land use, drainage control, suitable cultivation, suitable management etc.)**



# Problems excavation of A.S.S.

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## 1. Physical and chemical viewpoint of the soil

- (1) Affected by the flood with high groundwater level
- (2) Rapid subsidence of surface soil
- (3) Toxic organic matter for crops production
- (4) Surface soil is acidified when pyrite layer is oxidized
- (5) Lack of inorganic fertility (artificial manure), and disproportion of effect of fertilizer
- (6) Groundwater situation and soil environment is changed
- (7) others



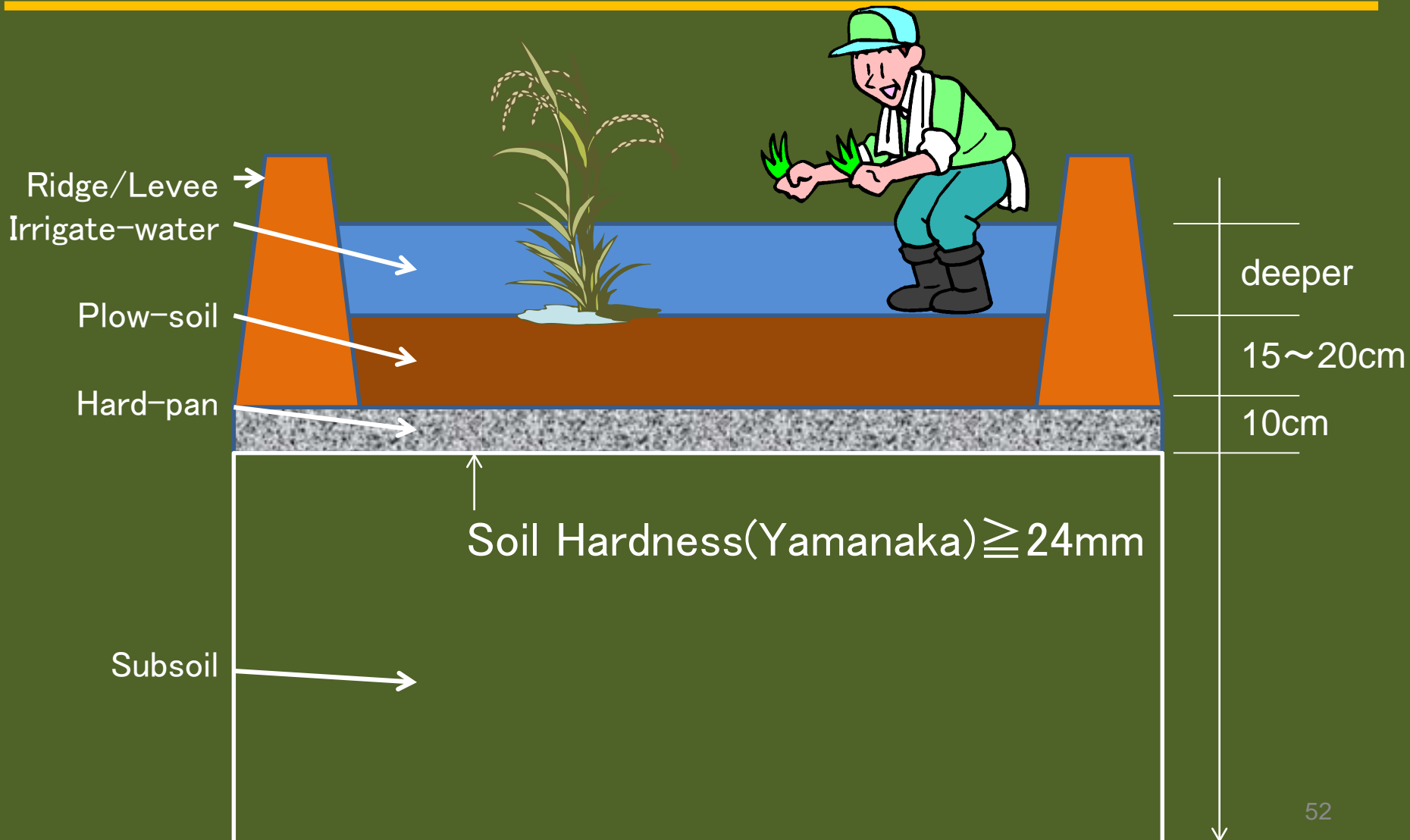
# Problems excavation of A.S.S.

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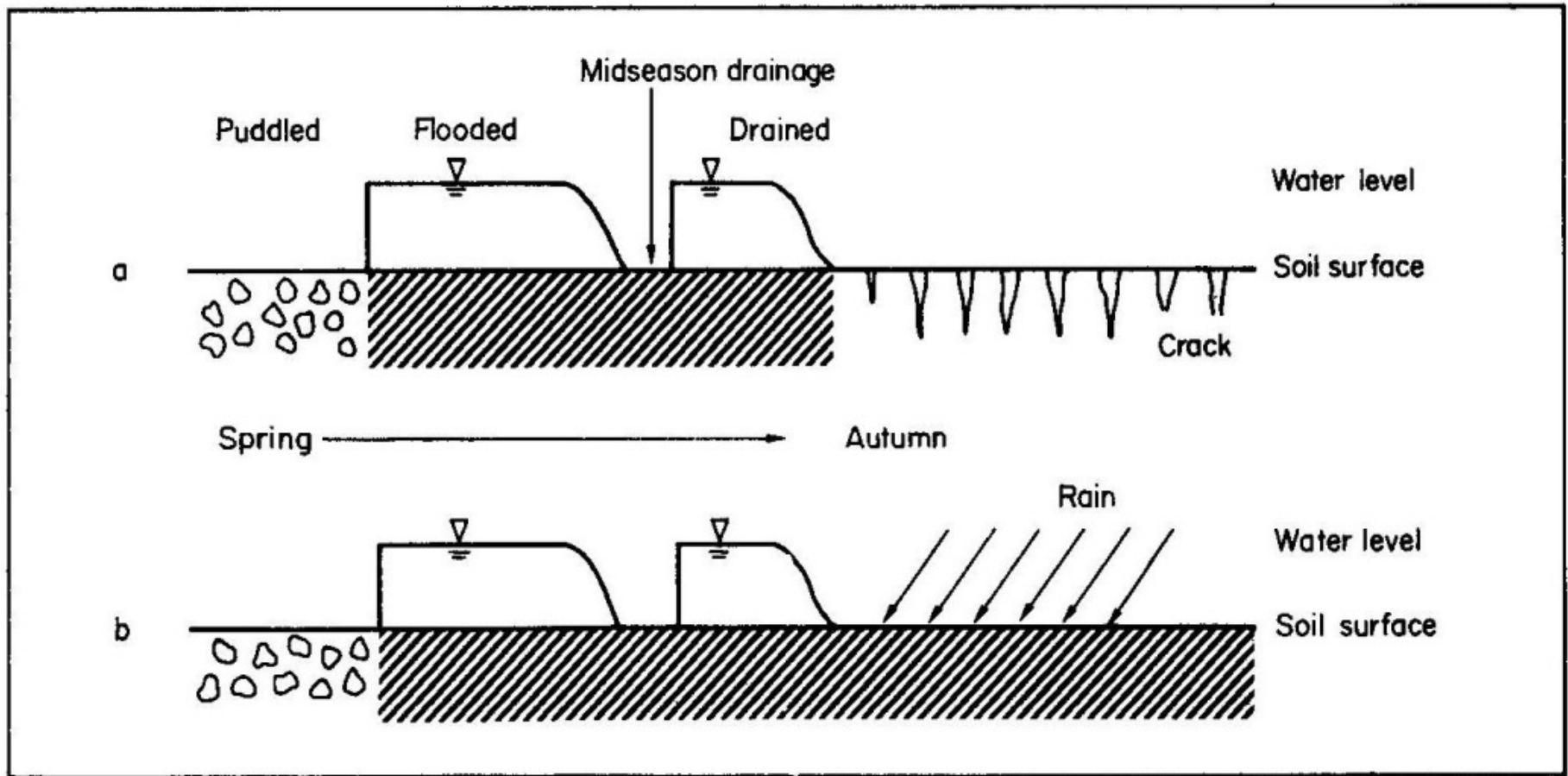
## 2. Environmental conservation and management

- (a) Control of peat soil subsidence and groundwater flow
- (b) Water control/management: drainage and irrigation
- (c) Suitable cultivation system
- (d) Control of microbe and harmful insect
- (e) Evaluation of environmental influence, and geographical investigation
- (f) Evaluation of social demand
- (g) Suitable land classification
- (h) others

# Soil layer structure (in Japan) of a typical rice field



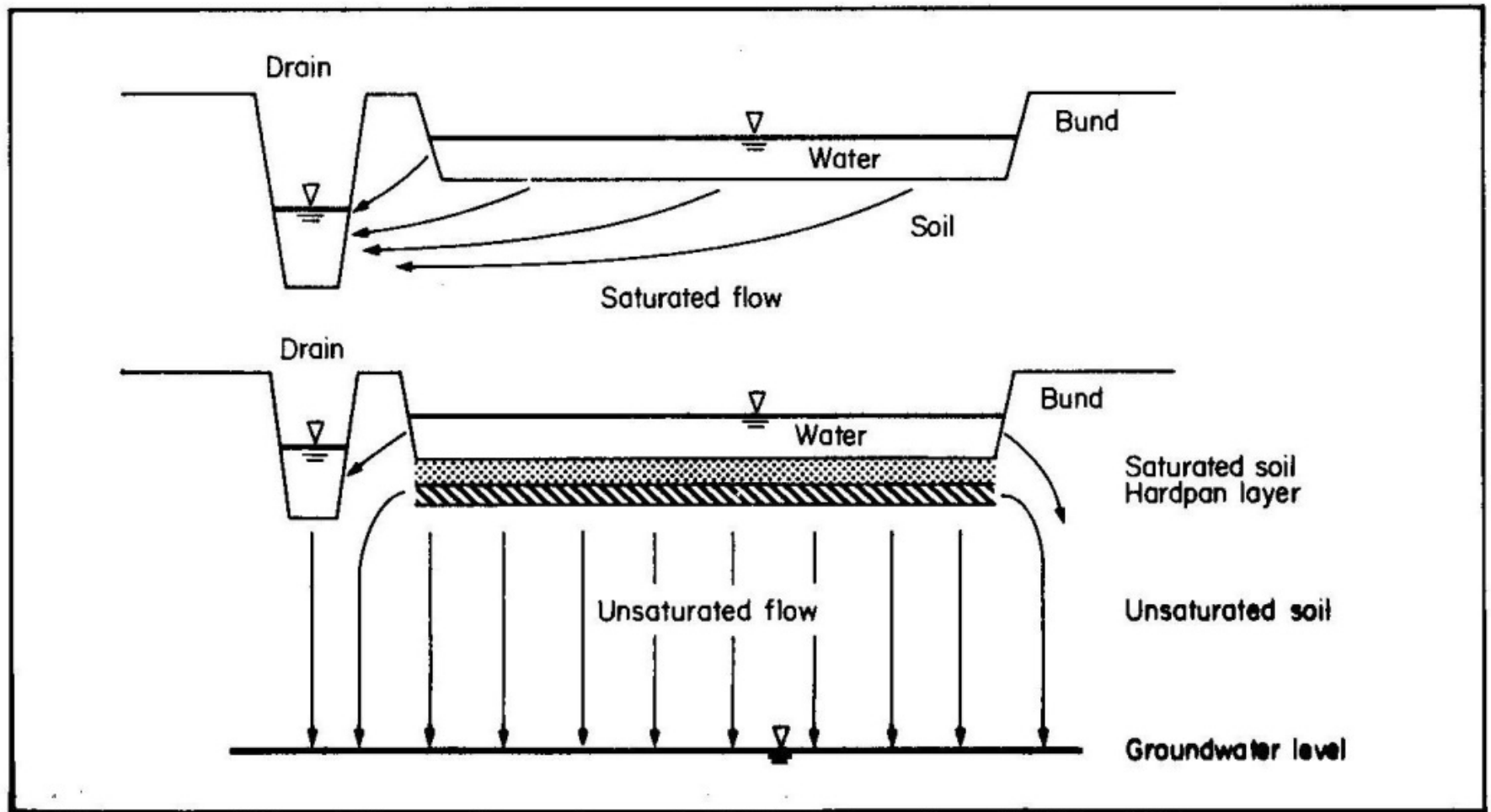




## Seasonal changes of soil surface conditions in Japan

**a) well-drained in region with low rainfall**

**b) poorly drained in region with high rainfall**



## ***Percolation in saturated and unsaturated subsoils in Japan***



**Thank you.**  
**ありがとうございました。**

