

APPENDIX C : SOIL AND NATURAL ENVIRONMENTAL CONDITIONS

APPENDIX-C SOIL AND NATURAL ENVIRONMENTAL CONDITIONS

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C.1 Soil Conditions

C.1.1 Soil Resources

Soil nomenclature of the Viet Nam's system was correlated with the 'World Reference Base for Soil Resources' (Refer to Table C-1). Based on the correlation, soil map was prepared as attached in the main report and distribution of respective soil type was prepared (Refer to C-2).

Properties, potentials and constraints of the soil type are summarized in the Table C-3 and potentials and constraints of acid sulfate soils are summarized in Table C-4.

C.1.2 Land Mapping Units

To prepare the Land Use Plan, Land Units Map of the study area was produced as attached in the following pages. The land units were distinguished by soil properties, water depth and surface water quality. (C-5)

C - 1: Soil Correlation

(The Viet Nam's and FAO Soil Classification 1998)

No	VN Soil Classification	Symbol	FAO/UNESCO Classification (FAO/ISRIC/ISSS,1998)	Symbol
1	Sandy ridge soil	Cz	<i>Cambic Arenosols</i>	ARb
2	Deposited alluvial soils	Pb	<i>Eutric Fluvisols</i>	FLe
3	Undeposited alluvial soils on river levee	Pb	<i>Gleyic Cambisols- Dystric Cambisols</i>	CMg- CMd
4	Undeposited & mottled alluvial soils	Pf	<i>Chromi-Gleyic Cambisols</i>	CMgx
5	Alluvial soils upper sulfidic material layer	Ps	<i>Bathi- proto Thionic Fluvisols</i>	FLtitd
6	Potential acid sulfate soils with sulfidic material within 50 cm from soil surface	SPp1	<i>Epi- proto thionic fluvisols</i>	FLtitp
7	Potential acid sulfate soils with sulfidic material at 50cm or deeper from soil surface	Sp2	<i>Endo- proto Thionic Fluvisols</i>	FLtitn
8	Actual acid sulfate soils with surfuric horizon within 50cm from soil surface	Sj1	<i>Epi orthi thionic fluvisols</i>	FLtiop
9	Actual acid sulfate soils having sulfuric horizon at 50cm or deeper from soil surface	Sj2	<i>Endo orthi Thionic Fluvisols</i>	FLtion
10	Actual Acid sulfate Soil covered by alluvium layer	Sd	<i>Areni endo orthi Thionic Fluvisols</i>	FLtionar
11	Typical grey soils on old alluvium	X	<i>Haplic Acrisols</i>	ACH
12	Degraded grey soils on old alluvium	Xb	<i>Albic Acrisols</i>	ACab
13	Mottled grey soils on old alluvium	Xf	<i>Plinthic Acrisols</i>	ACpl
14	Humic grey soils on old alluvium	Xh	<i>Humic Acrisols</i>	ACu
15	Gleyic grey soils on old alluvium	Xg	<i>Gleyic Acrisols</i>	ACg

**THE STUDY ON INTEGRATED AGRICULTURAL DEVELOPMENT PLAN
IN THE DONG THAP MUOI AREA VIET NAM FINAL REPORT**

Table C-2 Distribution of Soil Types in the Dong Thap Muoi Area

	Area ha		Dong Thap Province							Tien Giang Province			
			Cao Lanh Town	Hong Ngu district	Tan Hong District	Tam Nong District	Thanh Binh District	Cao Lanh district	Thap Muoi District	Cai Be district	Cai Lay district		
Arenosols													
Cambic Arenosols	647	0%	127	0	0	0	0	0	0	127	520	0	520
Cambisols													
Gleyic Cambisols / Dystric Cambisols / Chromic Gleyic	17,831	6%	13,413	2,318	5,716	0	1,516	3,005	858	0	4,418	3,444	974
Fluvisols (Non acidic)	125,804	43%	89,692	809	10,203	25	7,503	15,357	27,465	28,330	36,112	22,233	13,879
Eutric Fluvisols	24,636	8%	11,834	3,765	0	0	0	878	7,191	0	12,802	8,734	4,068
Fluvisols (Acidic)													
Bathic Protothionic Fluvisols	11,689	4%	11,629	0	580	0	2,945	890	4,129	3,085	60	60	0
Epi Protothionic Fluvisols	3,249	1%	3,249	0	0	15	3,234	0	0	0	0	0	0
Endo Protothionic Fluvisols	497	0%	497	0	497	0	0	0	0	0	0	0	0
Epi Orthithionic Fluvisols	13,744	5%	13,678	0	0	0	5,886	0	0	7,792	66	0	66
Endo Orthithionic Fluvisols	38,945	13%	35,914	0	0	4,722	12,986	2,195	3,806	12,205	3,031	2,271	760
Areni Endo Orthithionic Fluvisols	11,165	4%	11,165	0	1,165	3,774	6,097	0	0	129	0	0	0
Acrisols													
Haplic Acrisols	13,337	5%	13,337	0	845	11,735	757	0	0	0	0	0	0
Albic Acrisols	2,196	1%	2,196	0	0	2,196	0	0	0	0	0	0	0
Plinthic Acrisols	9,980	3%	9,980	0	641	4,722	4,617	0	0	0	0	0	0
Humic Acrisols	1,056	0%	1,056	0	0	1,056	0	0	0	0	0	0	0
Gleyic Acrisols	372	0%	372	0	0	372	0	0	0	0	0	0	0
River	15,170	5%	10,559	1,470	3,049	536	492	2,077	2,716	219	4,611	3,365	1,246
Total Area	290,318	100%	228,698	8,362	22,696	29,153	46,033	24,402	46,165	51,887	61,620	40,107	21,513

Table C.3 Properties, Potentials and Constraints of Soil Resources in the Study Area

Major Soil Group	Properties	Potentials and Constraints
<p>FLUVISOLS</p> <p><u>Subdivisions</u> Eutric Fluvisols (Thionic Fluvisols)</p>	<p>Chemically rich properties with a near neutral soil reaction except the case of Thionic Fluvisols (Acid Sulphate Soils).</p> <p>Physically, it may have a low bearing capacity because it may be wet through the presence of groundwater or floodwater.</p> <p>Infiltration rates are low in the backswamps because of the clayey nature. Whereas they have a high hydraulic conductivity on the natural levee due to more silty or loamy nature.</p>	<p><u>Potentials</u> Generally fertile and used for a wide range of crops particularly on the natural levees. Three crops of rice cultivation per annum are possible.</p> <p><u>Constraints</u> Constraints of Thionic Fluvisols (Acid Sulphate Soils) will be discussed in the following part.</p>
<p>Cambisols</p> <p><u>Subdivision</u> Gleyic Cambisols Dystric Cambosols Chromi-gleyic Cambisols</p>	<p>Saturated with water for long periods during the year.</p> <p>Rather fertile with a finer soil texture and a slower organic matter decomposition, and an influx of ions from adjacent higher lands.</p>	<p><u>Potentials</u> Presently used for rice cropping and may be used for a more wide range of purpose such as horticulture provided the groundwater table is lowered or groundwater seepage from the uplands is intercepted.</p> <p><u>Constraints</u> Periodical inundation occurs in the backswamps. They may need flood control through dykes and drainage. Nutritional problems (iron toxicity, H₂S gas) caused by prolonged inundation during cropping season associated with lowered redox potential.</p>
<p>ACRISOLS</p> <p><u>Subdivision</u> Haplic Acrisols Albic Acrisols Plinthic Acrisols Humic Acrisols Gleyic Acrisols</p>	<p>Low cation exchange capacity and low base saturation with strongly acidic subsoil.</p> <p>Generally thin surface horizon with a low amount of organic matter.</p> <p>A sharp increase in clay content with depth occurring over a short distance.</p>	<p><u>Potentials</u> Acrisols distribute on the northern part of the Study area of relatively high elevation with extensive dyke systems being prevented from severe impact of inundation.</p> <p><u>Constraints</u> Continuous cultivation generally requires recurrent inputs of nutrients and organic matter because of low CEC and base saturation. Root elongation is generally poor owing to subsoil's acidity.</p>
<p>ARENOSOLS</p> <p><u>Subdivision</u> Haplic Arenosols</p>	<p>Sandy nature. Soil structure is normally absent or very weakly developed</p> <p>Arenosols are very permeable and have rapid infiltration, high hydraulic conductivity and low water holding capacity.</p>	<p><u>Potentials</u> They are less fertile soil groups in the Study Area, however, they covers a negligible area. Water melons and a wide variety of crops.</p> <p><u>Constraints</u> Very permeable, rapid infiltration, low water holding capacity. Lack of sufficient amount of organic matter that acts as buffer necessitating meticulous management of water and nutrients.</p>

Table C-4 Properties of Acid Sulphate Soil in the Study Area (Part1)

<p>Vietnam's Classification FAO/UNESCO</p>	<p>Potential Acid Sulphate Soils, Sulfidic material 0-50cm (Sp1) Epi Protothionic Fluvisols</p>	
<p><u>Concept</u> These are the Fluvisols that have an appreciable amount of sulfides close to the soil surface. Permanently saturated at or close to the surface and many are nearly neutral in reaction.</p> <p><u>Definition</u> Having 'sulfidic soil material' within a depth of 50 cm below the soil surface. 'Sulfidic soil material' is waterlogged deposit containing sulphur (S) mostly in the form of Pyrite (FeS₂).</p>	<p><u>Potentials, Constraints, Hazard</u> The hazards associated with acidity are potential hazards and will not materialize unless the soils are drained or excavated. Once water table is lowered below the soil horizon containing the material, it is exposed to oxygen (O₂) and undergoes oxidation, resulting in generation of sulfidic acid (H₂SO₄). They are more susceptible to oxidation than Sp2 because the material lies close to soil surface.</p>	<p><u>Management</u> The sulphide remains stable as long as the soil remains submerged. Maintaining water table above the <i>soil surface</i> is the key in management of these soils, however, it would cause nutritional problems (iron toxicity, H₂S gas) associated with lowered redox potential.</p>
<p>Vietnam's Classification FAO/UNESCO</p>	<p>Potential Acid Sulphate Soils, Sulfidic material >50cm (Sp2) Endo Protothionic Fluvisols</p>	
<p><u>Concept</u> These are the Fluvisols that have an appreciable amount of sulfides at a deeper part than the Sp1. From the point of view of crop production, they are less hazardous than Sp1.</p> <p><u>Definition</u> Having 'sulfidic soil material' at a depth between 50 cm and 100cm below the mineral soil surface.</p>	<p><u>Potentials, Constraints, Hazard</u> They are less susceptible to oxidation because the layer containing sulfidic soil material lies at deeper part. Among the Thionic Fluvisols, these soils should be given the first priority for development.</p>	<p><u>Management</u> Water table may be lowered below soil surface, however, it should be above the layer containing sulfidic soil material.</p>

Table C-4 Properties of Acid Sulphate Soil in the Study Area (Part2)

Vietnam's Classification	Acid Sulphate Soils, Sulfuric horizon 0-50cm (Sj1)	
FAO/UNESCO	Epi Orthithionic Fluvisols	
<p><u>Concept</u> These are the acid sulphate soils that have been drained and oxidized at some time. The acidic layer lies at a shallow part. Soil pH is less than 4 and may be as low as 2.</p> <p><u>Definition</u> Having a 'sulfuric horizon' that has its upper boundary within 50 cm of the soil surface.</p>	<p><u>Potentials, Constraints, Hazards</u> The range of crops that can be grown is severely restricted and yields are low due to very high levels of acidity and toxicities of dissolved iron and aluminium. Soil pH usually increases upon submergence but iron toxicity and possibly sulphide or other toxicities may then occur. Physically soil ripening is arrested, so the soil remains soft at shallow depth. Engineering hazards include corrosion of steel and concrete, low bearing strength and uneven subsidence, very high permeability of undisturbed muds but low permeability and slow consolidation of reworked material, and the blockage of drains by ochre.</p>	<p><u>Management</u> Acidity may be corrected by liming but it may require more than 100 tonnes of limestone per hectare and this must be incorporated throughout the normal rooting depth of the crop. Unless limestone is available locally, it is not practicable to apply anything like the required amount.</p>
Vietnam's Classification	Actual Acid Sulphate Soils, Sulfuric material >50cm (Sj2)	
FAO/UNESCO	Endo Orthithioni Fluvisols	
<p><u>Concept</u> These are actual acid sulphate soil having acidic layer below 50 cm from the soil surface.</p> <p><u>Definition</u> Having a sulfuric horizon at a depth between 50 cm and 100cm below the mineral soil surface.</p>	<p><u>Potentials, Constraints, Hazards</u> Acidic material may move upward by capillary force during dry season.</p>	<p><u>Management</u> Acidity can be corrected provided that sufficient amount of irrigation water is available.</p>

Table C-5 Land Characteristics selected for Land Mapping Units in the Study Area

Land Characteristics	Diagnostic factors	Criteria used for delineation
		Code and Description
Soil	Soil Properties (Symbol:S)	<ol style="list-style-type: none"> 1. Soil having sandy loam texture, non acidity(Arenosols, Acrisols) 2. Soil having silty clay loams texture, fluvic properties, non acidity (Eutric Fluvisols, Gleyic/Dystric Cambisols) 3. Soils having clay texture, fluvic properties, non acidity (Chromi-Gleyic Cambisols) 4. Soil having clay texture, fluvic properties, sulfuric or sulfidic horizon within 0-50cm of top soil(Epi proto/orthi Thionic Fluvisols) 5. Soils having clay texture, fluvic properties, ssulfuric or sulfidic horizon at deeper 50cm below soil surface (Endo proto/orthi Thionic Fluvisols)
Surface Water Resources	Flooding Depth And Flooding Period (Symbol:F)	<ol style="list-style-type: none"> 1. Flooded <1.0m, within 1.5 month 2. Flooded >1.0-1.5m, within 2.0 month 3. Flooded >1.5-2.0m, within 2.5-3.0month 4. Flooded>2.0-2.5m, within 3.0months 5. Flooded>2.5-3.0m, within 3.5months 6. Flooded>3.0m, within 4.0 months
	Surface Water Acidity (pH4 at the beginning of raini season) Synbol:A	<ol style="list-style-type: none"> 1. Surface water acidified in June(monitring in 1991-1995) 2. Surface water acidified in June(monitring in 1992,1994,1996) 3. Surface water acidified in June and July (Monitoring in 1991-1996) 4. Surface water without acidification