

Updated Brazilian's Georeferenced Soil Database – an Improvement for International Scientific Information Exchanging

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1. Introduction

The Brazilian soils represented by this database are denominated accordingly the available classification system which follows a hierarchy based on attributes and diagnostic horizons constituting the frame of the system. All the classes of soil present properties and characteristics determining a differential behavior due to the action of formation agents on the originating material. This heterogeneity has been studied for many years in order to permit a major understanding about Brazilian soils.

The classification systems allow the information organization tracking knowledge development. The classification represents the art of designing systems with some intuitive ideas about their subdivisions and priorities. In this way, it can be understood why and how soil classification systems prepared by people with varied knowledge, techniques and practical expertise differ from each other.

The soil classification is still away from the improved level of development reached by the botanical or zoological classification, but relevant progress has been achieved (Resende et al., 2007). Although there isn't a worldwide unified system available yet, attempts have been made in that direction. Among the many systems of pedological classification, the Soil Taxonomy (United States, 1975, 1999) developed in the United States must be mentioned. It constitutes the most elaborated and comprehensive system; even though, it presents some problems regarding to tropical soils (Resende et al., 2007). To allow the classification of all kinds of soil in the planet, a system with special characteristics has been continuously developed by the FAO to elaborate the map of soils of the world (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, 1974). In this way, there is a tendency in many countries, including Brazil, to develop their own soil classification systems keeping a coherent relation with the FAO system and the Soil Taxonomy (Resende et al., 2007).

During the most intensive period of soil surveys in Brazil, there was not a consolidated soil classification system available yet. In this way, maps and pedological surveys reports

present a considerable range of differences in applied nomenclature, soil profiles classifications and legend compositions.

The Brazilian system of soil classification (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA], 1999, 2006) introduced significant modifications both in concepts and nomenclature. Because of that, an actualization and standardization is necessary to allow comparative analysis with the classifications applied in the previous surveys, which constitute the main source of data and relevant information for the system's development itself.

Updates of legends and pedological surveys have been done often with many objectives: a) just to update the legend; b) to unify legends of different maps with a specific objective, as the evaluation of agricultural suitability of lands; c) to allow fitting in other kinds of soil classifications; and d) to make easier the exchange of expertise among researchers from different countries. The update is also essential for the construction and use of a database to allow the treatment and use of information in a quick, adequate way firmed over the actualized bases.

In the last decades, the quick evolution of the methods and instrumentations used for the acquisition, storage, recovering, manipulation, analysis, access and distribution of data has facilitated the treatment of a great amount of data by the soil scientists. These techniques are indispensable for the monitoring and evaluation of the soil systems, their components and processes (Baumgardner, 1999).

The way as the data are stored in a database helps the organization, searching and updating of information. With this, the same data can be used for different applications reducing the space and effort (Assad & Sano, 1998). As examples it can be mentioned: (a) Digital Soil Map of the World (FAO, 1996); (b) SOTER - The World Soils and Terrain Database (Van Engelen, 1999); (c) CANSIS - Canadian Soil Information System (Coote & Macdonald, 1999); (d) NASIS - National Soil Information System (Soil Survey Staff, 1991); (e) Hydraulic Properties of European Soils (HYPRES) database (Nemes et al., 1999); and (f) Unsaturated Soil Hydraulic Database (UNSODA), in its second version already (Nemes et al., 2001).

In this way, a database of Brazilian soils was developed starting from soil surveys done by the former "Soil's Conservation and Survey National Service" (SNLCS) of Embrapa (actual Embrapa Solos), previous institutions and the RADAM Brazil Project (Cooper et al., 2005). This basis allows just quantitative evaluation because of the lack of an updated soil's profile classification related to nomenclature changes and time based taxonomic distinction criteria. Included in the described context, this work makes an analysis of the structure and an update of the soil's database profile classification to make available a more friendly and practical database for future research and analysis. Through a consistent and compatible identification of the database registers relatively to the soil's profiles, it is possible to update the basis comparing similar soils in distinct regions, defining central- and dispersion-values of the attributes, or generating studies focusing on the update of the classification system under analysis. Besides, this study furnishes information to help in the identification of the different classes of soil applying an approximated correspondence involving the Brazilian, American Soil Taxonomy and International Classification WRB/FAO systems.

2. Soil database

This work has used information originated from soil surveys in regional scale, covering a great portion of the Brazilian territory (Figure 1), contained in a Brazilian database soil (Cooper et al., 2005).

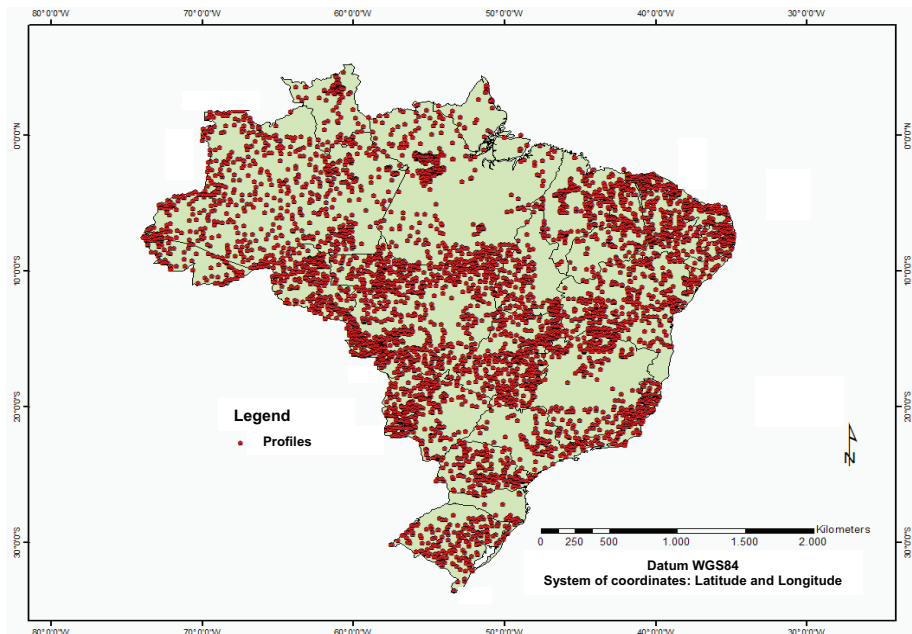


Fig. 1. Brazil map showing the political division and locations of the soil profiles used in the study

The works which originated the database came from official soil surveys chosen to assure the total coverage of the Brazilian territory. They were published between 1960 and 1986 by the former Soil's Conservation and Survey National Service (SNLCS-Embrapa), previous institutions, and the RADAM Brazil Project as described in table 1.

RADAM Volumes	Region	Year	Bulletin	Region	Year
1	São Francisco River and Aracaju	1973	34 SNLCS - BT N°60	North of Minas Gerais	1979
2	Teresina and Jaguaribe	1973	35 SNLCS - BP N°27 Vol. I	Paraná	1984
3	São Luís and Fortaleza	1973	36 SNLCS - BP N°27 Vol. II	Paraná	1984
4	Araguaia and Tocantins	1974	37 SNLCS - BP N°28	Pole Trombetas -PA	1984
5	Belém	1974	38 SNLCS - BP N°29	Pole Carajás - PA	1984
6	Macapá	1974	39 SNLCS - BP N°30	Urucará - AM	1984
7	Tapajós	1975	40 SNLCS - BP N°35 Vol. II	Maranhão	1986
8	Boa Vista / Tumucumaque	1975	41 SNLCS - BP N°36 Vol. II	Piauí	1986

RADAM Volumes	Region	Year	Bulletin	Region	Year
9	Tumucumaque /Tocantins	1975	42 SNLCS - BP N° 32	Barreirinha - AM	1984
10	Santarém	1976	43 SNLCS - BP N°18	Pole Roraima - RR	1983
11	Neblina Peak	1976	44 SNLCS - BP N°19	Tefé - AM	1983
12	Rio Branco	1976	45 SNLCS - BP N°20	Espírito Santo	1977
13	Javari/Contamana	1977	46 SNLCS - BP N°23	Ceará	1972
14	Içá - AM	1977	47 SNLCS - BP N°24	Bahia	1972
15	Juruá - AM	1977	48 SNLCS - BP N°31	Carneiro - AM	1984
16	Porto Velho	1977	49 SNPA - BT N° 12	São Paulo	1960
17	Purus - AM	1978	50 SNLCS - BP N°35 Vol. I	Maranhão and Piauí	1986
18	Manaus - AM	1978	51 SNLCS - BP N°15	Pole Pré-Amazônia Maranhense	1982
19	Guaporé	1979	52 SNLCS - BP N°16	Ariquemes - RO	1982
20	Juruema	1980	53 EPFS - BT N°13	Espírito Santo and Minas Gerais	1970
21	Fortaleza	1981	54 DPP - BT N°26 Vol. II	Pernambuco	1972
22	Tocantins	1981	55 SNLCS - BP N°26	Maranhão and Piauí	1984
23	Jaguaribe/Natal	1981	56 DPP - BT N°18	South of Mato Grosso	1971
24	Salvador	1981	57 EPFS - BT N°15	Paraíba	1972
25	Goiás	1981	58 SNLCS - BT N°45	Espírito Santo	1978
26	Cuiabá	1982	59 SNLCS - BT N°38	Left Margin of São Francisco River - BA	1976
27	Corumbá	1982	60 SNLCS - BT N°52 Vol. II	Right Margin of São Francisco River - BA	1977-1979
28	Campo Grande	1982	61 DPP - BT N°21	Rio Grande do Norte	1971
29	Brasília	1982	62 DPP - BT N°28	Ceará	1973
30	Aracaju	1983	63 SNLCS - BP N°14	Apiaú - RO	1982
31	Goiânia	1983	64 SNLCS - BP N°17	Mato Grosso	1983
32	Rio de Janeiro / Vitória / Goiânia	1983	65 SNLCS - BP N°9	Barreirinha - AM	1982
33	Porto Alegre / Uruguaiiana / Lagoa Mirim	1975	66 SNLCS - BP N°36 Vol. I	Piauí	1986

* RADAM - Exploratory Soil Surveys (Radam Brazil Project); DPP - Division of Pedologic Research; EPFS - Staff of Pedology and Soil Fertility; SNPA - National Service of Agronomic Research (Committee on Soil); SNLCS - Soil's Conservation and Survey National Service (now Embrapa Solos); BP - Research Bulletin; BT - Technical Bulletin.

Table 1. Source and year of the surveys used in the database

The database was implemented using the Microsoft Excel® format, including a set of data relative to the characteristics and analytical results of a superficial and a subsuperficial soil horizon of each profile (Table 2). The profiles are identified by codes referent to the publication source together with their original numeration, while for the horizons it was maintained the same designations used in the original works. The variables for which the data were compiled and placed in a distinct column are constituted by: code from the publication source, number of the profile, year of the survey, latitude, longitude, original soil classification, slope, drainage, symbol and depth of the horizon, moist color, macroclastic composition (pebbles and cobbles), particle size distribution (coarse sand, fine sand, silt and clay), content of oxides obtained by sulfuric acid digestion (SiO_2 , Al_2O_3 , Fe_2O_3), pH in H_2O and in KCl, organic C, organic matter, total N, exchangeable cations (Ca^{2+} , Mg^{2+} , $\text{Ca}^{2+} + \text{Mg}^{2+}$, K^+ , Na^+ , Al^{3+} , H^+ , $\text{H}^+ + \text{Al}^{3+}$), CEC, base sum, base saturation and aluminum saturation (Cooper et al., 2005).

Starting from this initial basis, and after proceeding with several adjustments and distortion corrections, in some cases through search in the original works, it was done the actualization of the soil profiles classification accordingly to the new version of the Brazilian system of soil classification (EMBRAPA, 2006) followed by the exportation of the data to a database management system, the Microsoft Access®. In that way, it was constituted the database of Brazilian soils which presents qualitative characteristics described in a numerical format containing 10,950 horizons referring to 5,479 soil profiles and 57 columns with the above mentioned variables and the actualized classification and respective degree of reliability (Benedetti et al., 2008). Each profile has a spatial indication related to its location on the earth surface, which means, has its coordinates (latitude and longitude) in the system of coordinates DATUM: WGS 84. The access to the database with the updated classification of the soil profiles can be done in the following web address: www.esalq.usp.br/gerd.

For the update of soil profiles database classification, compatible with the new version of the Brazilian soil classification system (EMBRAPA, 2006), it were considered the characteristics of the two horizons of each profile (superficial and subsuperficial) contained in the database, considering the criteria established for the attributes and diagnostic horizons, and the concept and definition of the known classes of soil. The taxonomic fitting of the soil profiles was done up to the fourth categorical level, and for some soils it was included the distinction in fifth level referred to the occurrence of alic character (Al saturation $\geq 50\%$ and $\text{Al}^{3+} \geq 0.5 \text{ cmol}_c/\text{kg}$) when pertinent.

Degrees of confidence, represented by numbers from 1 to 4, were adopted to express the adequacy of the adjustment obtained in the taxonomic fitting, in one of each four categorical levels, mentioning that many profiles would need complementary data for more precisely updating the classification. The value 1 indicates taxonomic fitting with elevated degree of confidence, which reduces progressively with the increasing of the values. The value 2 expresses some doubt in relation to the classification at the considered categorical level, as a function of the unavailability of some analytical data of minor relevance, and the previous profile classification suggests the present fitting as the most probable. The value 3 follows a similar line of reasoning, but in this case the doubt is increased due to some missing data, being the present classification based exclusively on the previous denomination. The value 4 was applied for situations when it was not possible to complete the update.

Code	Variable	Description	Units
ClassfSoil	Soil Classification	Soil name according to the original document	
DecVal	Slope	Inclination of the soil surface in relation to a flat reference	%
Drain	Drainage	Velocity at which water is removed from the soil profile	
SoilDepth	Soil Depth	Lower limit of the horizon	cm
HzSimb	Soil Horizon Symbol	According to the pedological convention	
HzDepth	Horizon Depth	Depth range registering the beginning and end of the horizon	cm
Munsell Color	Munsell Color	Description according to Munsell notation	
CG	Cobble	Material > 20 mm in diameter	(%)
FG	Pebble	Material between 20-2 mm in diameter	(%)
CS	Coarse Sand	Material between 2-0.2 mm in diameter	(%)
FS	Fine Sand	Material between 0,2-0.002 mm in diameter	(%)
Sand	Sand	Material between 2-0.005 mm in diameter	(%)
Silt	Silt	Material between 0.05-0.002 mm in diameter	(%)
Clay	Total Clay	Material < 0.002 mm in diameter	(%)
SiO ₂	SiO ₂	Silicon oxide content	(%)
Al ₂ O ₃	Al ₂ O ₃	Aluminum oxide content	(%)
Fe ₂ O ₃	Fe ₂ O ₃	Iron oxide content	(%)
pH_H ₂ O	pH measured in water	pH value determined in a mixture with a specified relationship between soil and water	
pH_KCL	pH measured in KCL solution	pH value determined in a mixture with a specified relationship between soil and 1mol L ⁻¹ KCl	
C	Organic Carbon	Content of organic carbon in soil	(%)
MO	Organic Matter	Content of organic matter in soil	(%)
N	Total Nitrogen	Content of total nitrogen in soil	(%)
ExCa	Ca ²⁺	Content of exchangeable calcium	(cmol _c /kg)
ExMg	Mg ²⁺	Content of exchangeable magnesium	(cmol _c /kg)
ExK	K ⁺	Content of exchangeable potassium	(cmol _c /kg)
ExNa	Na ⁺	Content of exchangeable sodium	(cmol _c /kg)
ExAl	Al ³⁺	Content of exchangeable aluminum	(cmol _c /kg)
ExH	H ⁺	Content of exchangeable hydrogen	(cmol _c /kg)
Ex_H_Al	H ⁺ + Al ³⁺	Content of exchangeable hydrogen and aluminum	(cmol _c /kg)

Code	Variable	Description	Units
CTC_pH7	Cation Exchange Capacity at pH 7.0	Sum of exchangeable Ca, Mg, K, Na, H and Al (T value)	(cmol _c /kg)
SumB	Base sum	Sum of exchangeable Ca, Mg, K and Na (S value)	(cmol _c /kg)
SatB	Base Saturation	Relationship between sum of bases and cation exchange capacity (V value)	%
SatAl	Aluminum Saturation	Relationship between exchangeable aluminum and sum of bases more exchangeable aluminum (m value)	%

Table 2. Code, description and units of representation of the database variables

3. Brazilian soils: A panoramic vision

The set of data, referring to physical, chemical and morphological attributes, which includes also information about location, depth and drainage, made possible the updating of the classification of almost all the soil profiles compounding the database. Figure 2 presents the representativeness of the classes of soil in elevated categorical level when compared with their total area of occupation in the Brazilian territory.

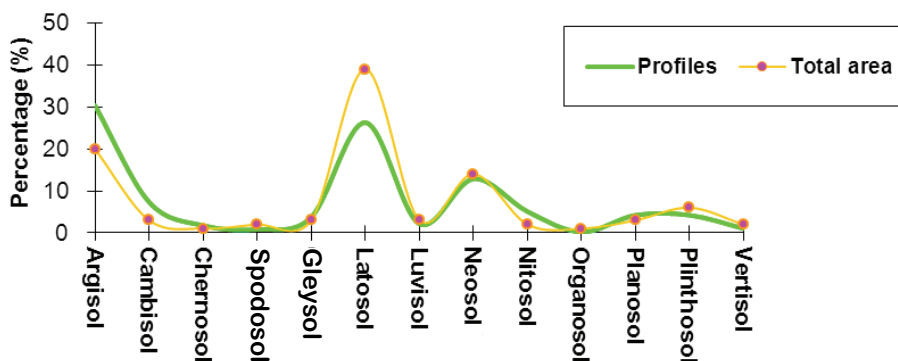


Fig. 2. Percentage of profiles in the database compared with the percentage of each class of soil in total area of Brazil

The soils were classified up to the fourth categorical level, being the alic character used when pertinent for distinction of soils in the fifth categorical level. With all classes in the most elevated categorical level (order) represented in the database, from the present actualization resulted 281 classes of soil in the subgroup level (besides three classes in suborder level referring to profiles that couldn't be classified in lower levels), for which the relation with the original classification and respective profile number are available for downloading in the following address: www.esalq.usp.br/gerd.

Through the comparison between the previous classification and the present fitting of the soil profiles in their various hierarchic levels many relevant aspects could be observed. From this evaluation emerged some characteristics expressed in the previous denomination that couldn't find a correspondence among the classes envisioned by the present SiBCS (Brazilian System of Soil Classification), both in the previous and actual versions, especially in the fourth categorical level, which resulted in loss of information. Keeping in mind to release these information to the international community and also to establish an approximated correlation between the soil classes in the Brazilian classification with the American classification "Soil Taxonomy" and with the International WRB/FAO systems, each soil class is commented individually as follows:

3.1 Argisols

With expressive participation in the database, referent to 1,660 soil profiles representing 30.29% of the total, the Argisols comprehend the majority of the soils previously classified as Podzolic soils, that present textural B horizon with low activity of clay, or with high activity of clay and low base saturation.

In this class it were also included three soil profiles previously classified as Structured Dusky Earth, that present medium texture and could not be fitted as Nitisols (class that put together almost all the former Structured Dusky Earth), and a Rubrozem profile, which by the first edition of the SiBCS would be classified as Alisol (EMBRAPA, 1999), class excluded of the present version. With the extinction of this last class and pertinent updates of the definitions of Argisols, which by now comprehend soils with elevated clay activity conjugated with dystrophic or alitic character (EMBRAPA, 2006), some distortions were corrected as the case of the profile 83 in the soil survey from the "Uruguaiana/Lagoa Mirim report" (Brasil, 1975d). Originally classified as Ta Alic Gray-Brown Podzolic soil, this soil would not have taxonomic fitting accordingly to the previous edition of the system (EMBRAPA, 1999), stated that the high activity of the clay fraction would exclude it from the Argisol class, while the concentration of exchangeable Al inferior to 4 cmol_c/kg made impossible its fitting as Alisol, also not fitting the requirements of any other class in the order level. The introduced modifications allowed the classification of this soil as Argisol, at the same time that the reformulation of the concepts of this class in the suborder level (2nd categorical level) led to its fitting as Gray-Brown soil, recently included class, and in third level as Alitic, class now incorporated to the system and that corresponds to part of the Alisols in the previous version.

The inclusion of the Gray-Brown Argisols, as mentioned above, allowed the distinction between soils which have the darkening of the superior portion of the textural B horizon as remarking characteristic, referent to the former Gray-Brown Podzolic soil. Because of the strong correspondence between the previous- and the currently-employed criteria on these soils reconnaissance, the taxonomic fitting of the soil profiles without specification of the B horizon color is based on the previous denomination. However, for some soils in this class it was not possible the fitting in lower taxonomic levels, because it is recognized only one class in the third categorical level, referring to soils with alitic character.

A good correlation was also observed between the actual classes of the second categorical level, referent to Gray-, Yellow- and Red-Argisols and the former Gray-, Yellow- and Dark Red- Podzolic soils, respectively. As a function of the current concepts, this last class presents some soils in which the color hue a little bit yellower than 2.5YR (in general 3.5YR)

are now fitted as Red-Yellow Argisols. Different from the others, the former Red-Yellow Podzolic soils present relevant variation in the taxonomic fitting in the second categorical level, distinguished in Yellow Argisols (with dominance of colors having hue 7.5YR or yellower) and Red-Yellow Argisols (B horizon color redder than 7.5YR and yellower than 2.5YR, except when hue is 5YR with value and chroma < 4), and also in Red Argisols (hue 2.5YR or redder). Therefore, in the absence of information about the B horizon color, it was considered for these soils a more elevated degree of uncertainty in the actualization of the classification in this categorical level relatively to the others.

In the great group level (third categorical level), the available data allow for the majority of the profiles a taxonomic fitting with increased confidence. However, for the Yellow Argisols it is notable the impossibility of distinction based on the activity of clay fraction, differently from the other classes in the same level. In this way, the profile 23 from the soil survey of the Fortaleza region (Brasil, 1981a), previously classified as Ta Alic Red-Yellow Podzolic soil, for example, fits as Yellow Argisol, due to its yellow colors, and as Dystrophic in the third level, although it presents high activity of clay. Also in the fourth categorical level some differential characteristics expressed in the former classification are not considered in the soils distinction by the new system. The profile 32 of the soil survey of Fortaleza region (Brasil, 1981a), formerly classified as plinthic abruptic Alic Red-Yellow Podzolic soil, for example, fits as abruptic Dystrophic Yellow Argisol, because it is not considered in the SiBCS the possibility of fitting soils having simultaneous occurrence of such characteristics. Besides, the occurrence of transitional character indicated by the latosolic and cambic denomination are not distinguished in some cases, as example of the profile 79 of the soil survey of Rio Branco region (Brasil, 1976c), previously classified as latosolic Alic Red-Yellow Podzolic soil, and the profile AE2 of the soil survey of the pilot area at Barreirinha-AM (EMBRAPA, 1982) denominated moderate A cambic Tb Alic Red-Yellow Podzolic soil, which following the current system fits as typic Aluminic Red-Yellow Argisol.

Establishing a high categorical level correspondence with the system proposed by the FAO, the Argisols could be approximated to the classes Acrisols, Lixisols and Alisols, while for the American classification Soil Taxonomy these soils would be approximated to the classes Ultisols and Oxisols (Kandic). These classes present as main diagnostic features the clay illuviation to the subsuperficial horizons generating a textural gradient.

3.2 Cambisols

This class covers the vast majority of soils previously identified by the same name, used in order level to designate soils having restricted pedogenetic development, characterized by the presence of incipient B horizon, excepting those of the eutrophic character, with high activity clay and chernozemic A horizon, now included in Chernosol class.

Among profiles that make up the database, 397 were classified as Cambisols, which represents 7.25% of the total. While keeping the former name in the first categorical level, even without major changes in the criteria for identification, the soils of this class have suffered a systematic structuration in all subsequent levels. The distinctions between them, represented in a low systematic way by the former nomenclature, are now distributed and hierarchically organized in the second, third and fourth categorical levels.

In the suborder level, three classes are recognized: Humic Cambisols, characterized by the presence of humic A horizon; Fluvic Cambisols, referring to the soils of alluvial origin; and Haplic Cambisols, which cover the other soils of the class, whose characteristics do not meet

the requirements of the earlier ones. Of these, only the Fluvic Cambisols, class now incorporated into the classification system (EMBRAPA, 2006) and whose distinction requires a comprehensive characterization of the entire depth of the profile, or even the environment of occurrence, making its recognition difficult from the data available here, are not listed in the database. It was also observed for some profiles, a certain difficulty for the fitting as Humic, due to lack of further information about the superficial horizon.

The absence of more complete analytical data also hampered the taxonomic fitting in lower categorical levels, which increases the uncertainty about the classification. The impossibility to confirm the carbonatic nature, for example (results related to the concentration of CaCO_3 are not present in the database), led to the fitting as Carbonatic in the third categorical level, based on the previous name, or some characteristic that would suggest the occurrence of that character within the specified control section. Thus, the classification of the profile 244 of the soil survey of the right margin of the São Francisco River (EMBRAPA, 1977-1979) as typic Carbonatic Haplic Cambisol is based on the supposed occurrence of the carbonatic character as indicated by the previous classification (moderate A carbonatic C Tb Eutrophic Cambisol) within the first 120 cm depth.

In general, the current structuration of the classification system provided a more accurate discrimination, better representativity and a more adequate basis of comparison for Cambisols. Such result is not always observed for other classes of SiBCS. Certain distinctions afforded by the former nomenclature, however, are not represented in the current system, for example soils previously identified as Brown Cambisols, typical of the subtropical environment of southern Brazil, which currently are not being discriminated. Some characteristics are also not included in the fourth categorical level, referring to intermediate or special characteristics. Thus, for the profile 29 of the soil survey of Mato Grosso (EMBRAPA, 1983), previously classified as chernozemic A podzolic Tb Eutrophic Cambisol, the transitional characteristic expressed in the original classification was not considered, having been framed as typic Eutrophic Tb Haplic Cambisol.

The plinthic character used to distinguish soils with not enough plinthite to be characterized as plinthic horizon (EMBRAPA, 2006), is not included in classes distinction of the 4th categorical level for the Eutrophic Ta Haplic Cambisols, since the plinthic class is not considered in the fourth categorical level. Thus, soils originally classified as moderate A plinthic Ta Eutrophic Cambisols like the profile 128 of the soil survey of the State of Maranhão (EMBRAPA, 1986a), or the profile 13 of SNLCS-BP-26 (EMBRAPA, 1984), lost the reference indicative of plinthite presence (expressed both in the previous classification as in the designation of the subsurface horizon), being classified as typic in the fourth level.

The Brazilian Cambisols have close correlation with the American and International systems due mainly to their transitional feature in the formation process, characterized by a not very expressive B horizon in the soil profile. Their names are derived from the classification of the soil map of the world by FAO, where they are known as Cambisols. The American classification reports the origin of their names in the conditions of pedogenesis, calling them Inceptisols.

3.3 Chernosols

A total of 87 soil profiles, representing approximately 1.59% of the database, were classified in this class, which groups soils previously named as Brunizens, Reddish Brunizens and Rendzinas, plus some eutrophic Cambisols, with high clay activity and chernozemic A

horizon. The reunion of these soils in a class on level of order reflects the importance attached to chemical and mineralogical characteristics together with the presence of chernozemic A horizon, with important implications for the sustainable use and management.

In the second categorical level, we observed a strong correspondence between Rendzinas and Reddish Brunizens with the current classes of Rendzic Chernosols and Argilluvic Chernosols, respectively, while the former Brunizens and Cambisols were classified as Haplic. However, for some profiles, the taxonomic classification was a little prejudiced because there was not enough available complementary information particularly with regard to colors of all the extension of the B horizon needed to distinguish the Ebanic Chernosol (dark color, almost black), or even because this horizon was not represented in the database. Thus, only the profile 57 of the soil survey of the south of the former State of Mato Grosso (Brasil, 1971a), formerly called Reddish Brunizem, could be classified as Ebanic Chernosol.

In the level of great group (third categorical level) the main limitation for a better taxonomical classification was related to the lack of data referent to the carbonatic character. Thus, the classification as Carbonatics was based on the previous name or even on the indication of the carbonatic character given by the subordinated designation of the subsurface horizon (EMBRAPA, 1988b).

The insufficiency of data also made it difficult to classify in the fourth categorical level (subgroup). Thus, several profiles were classified as typical as an attempt, taking into account the impossibility to confirm the occurrence of distinctive characteristics of other classes. In addition, some properties expressed in the previous name don't correspond to the classes provided by the actual system, both in its previous version (EMBRAPA, 1999) as in the current one (EMBRAPA, 2006), for not being included in the key, a class that can distinguish it, which results in loss of information. This situation is exemplified by the profile 34 of the RADAM Brazil Project (Brasil, 1981a), originally classified as abruptic solodic Reddish Brunizem, now classified as abruptic Orthic Argilluvic Chernosol. Also for profiles 48 (Brasil, 1972a) and 34 (Brasil, 1981a) of the RADAM Brazil Project, both named as vertic abruptic Reddish Brunizem, the differential characteristic due to the abrupt textural change is not addressed in the current classification.

The Chernosols occupy small areas in the Brazilian territory, but they have great expressiveness in temperate regions. They can be correlated with the Chernozems, Kastanozems, Phaeozems and Greyzems classes in the legend of the WRB / FAO. In the American system these soils correspond to Mollisols that exhibit high activity of clay.

3.4 Spodosols

Corresponding to soils that are distinguished by the presence of the spodic B horizon, this class includes the former Podzols and Hydromorphic Podzols, represented in the database by 53 soil profiles, which equals to 0.97% of the total.

In the second categorical level (suborder), these soils were classified as Humiluvic and Ferriluvic. However, the taxonomic fitting in this level was somewhat difficult due to the lack of complementary morphological information and, in some cases, the lack of data relative to the B horizon. For these profiles, the value 3 was used to represent the degree of confidence in order to provide the continuity of classification, since the distinction of classes in the subsequent categorical levels bases on equivalent concepts and denominations,

especially in the great group level. In general, the classification in this hierarchical level also has a certain amount of uncertainty (degree of confidence 2), due to the lack of information about environmental conditions, once the presence of water table or saturation by water within 100 cm from the soil surface are distinctive criteria of classes. Therefore, the classification of the profiles, as Hydromorphics or Orthics, was based on the previous classification that, in general, distinguished soils subjected to hydromorphic conditions or not. Similarly, the fourth level of classification (subgroup) was also a bit impaired by the absence of complementary data of profiles that would allow a more precise taxonomic fitting. Therefore, the actualization of classification of soil profiles that belong to the class of Spodosols, in level of suborder, great group or subgroup, is about a kind of approximation, in correlation with the previous classification.

The Spodosols of American Soil Taxonomy include diagnostic characteristics similar to the spodic B horizon of the Brazilian Espodosols. The legend of the WRB / FAO retains the name formerly used by the mapping of soils in Brazil, as can be seen in the database the designation of Podzols.

3.5 Gleysols

Class of soils consisting of mineral material, whose genesis is related to strong hydromorphic conditions, expressed in the presence of gley horizon, and absence of distinctive features of Plinthosols or Planosols. This class is represented in the database by 214 soil profiles, which correspond to 3.91% of the total. They include soils formerly and generically named as Gleysols or Gley soils, which often were separated in Humic Gley, Low Humic Gley, Tiomorphic Gley and Saline Gley. It includes, in addition to those, the Gray Hydromorphic soils.

As observed for other classes, the lack of data concerning the full extension of the profiles resulted in difficulty for some taxonomic framework, inclusive in the level of order, due to their subsurface horizons contained in the database do not show enough coloration to distinguish the gley horizon. In these cases, the classification in this class was based on the previous name, in the assumption that other horizons of the profiles in question meet the requirements of this diagnostic horizon.

All classes of the second categorical level defined by the current system are contained in the database, although for some profiles the taxonomic classification at this level also provides some degree of uncertainty, especially for Salic Gleysols, since no data are presented relative to the electrical conductivity. Also for some soil profiles classified as Tiomorphic Gleysols, in which the pH of the horizons contained in the database are slightly above 3.5, therefore insufficient to characterize sulfuric horizon or sulfidric materials, requiring evaluation of other horizons for a more precise definition, the classification in the second level was established based on the former designation, with value 2 for the degree of confidence.

The distinction of these soils in the third categorical level was satisfactory, without significant limitations. Already the fitting in the fourth level, highlights the impossibility of differentiation based on some characteristics formerly included in the distinction of these soils, such as the great capacity of swelling and shrinkage of the soil material, expressed in the vertic designation, such as the profile 146 of the soil survey of the State of Maranhão (EMBRAPA, 1986a), previously classified as moderate A solodic with tiomorphism vertic Ta Eutrophic Gleysol, which was classified as solodic Orthic Tiomorphic Gleysol.

It is also important to emphasize the question of the current fitting of the former Gray Hydromorphic, whose distinction related to the presence of textural B horizon, is addressed only in the fourth categorical level, referring to the class of argisolics. However, in the event of sufficient characteristics for classification as plinthic, such as the profile 132 of the RADAM Brazil Project (Brasil, 1981b), that distinction is impossible, since these ones, as well as the leptics, take precedence in the sequence of the identification key. Moreover, it is not possible to differentiate soils with other special characteristics, such as the presence of fragipan, as occurs with the profile 37 of the soil survey of the left margin of the São Francisco River (EMBRAPA, 1976c).

The Gleysols are developed over unconsolidated materials (sediments and saprolites) and are greatly influenced by the occurrence of prolonged flooding due to the position of the water table near the surface. They are recognized in the legend of the WRB / FAO as Gleysols, except for classes of Salic Gleysols, that correlate to Solonchaks. Unlike what occurs in the two systems mentioned above, the American classification Soil Taxonomy identify the inherent properties of these soils in lower levels of classification. The Gleysols can be correlated with the Entisols (Aqu-alf-and-ent-ept), while Gleysols having saline character can best approach classes of the Aridisols and Entisols (Aqu-sulfa-hydra-salic).

3.6 Latosols

Characterized by a very advanced stage of development, as evidenced by the insignificant occurrence or even absence of weatherable primary minerals, and the presence of latosolic B horizon, the Latosols constitute the largest class of territorial expression and agricultural potential of the country, being explored with various crops, reforestation and pasture (Ker, 1997). They represent 25.79% of the database, with a total of 1,413 soil profiles.

For this class, which name was maintained in the level of order in the current system, some subdivisions were already established since the 60's, as exemplified the denominations of Red-Yellow Latosol, Dark Red Latosol and Dusky Red Latosol, to which, over time, it were added Yellow Latosol, Brown Latosol, Ferriferous Latosol and Una Latosol. These designations were, partially, maintained in the distinction of classes in the second categorical level, although the differentiation criteria have changed. In the current system, the distinction of these soils in this level is based only on the color of the B horizon, while previously competed in addition to this, other characteristics such as the iron oxide content obtained by sulfuric acid digestion, which in low contents (< 8 % of Fe_2O_3) is a sure indicator of strong cohesion ("hard-setting soils"), condition very far from the granular structure (high friability), typical of most of the Brazilian Latosols. In this context, the previous classification system was more informative. Thus, the former Dark Red-, Dusky Red-, and Ferriferous- Latosols, generally refer to the currently Red Latosols, with the distinction of the iron oxide content used in the third categorical level. The former denominations Red-Yellow-, Yellow-, and Brown- Latosols still remain, but while for this last class there is a strong correspondence between past and present distinctive criteria, for the other two classes there are not, beyond nomenclature, a direct relationship with the classes of the current system. The Yellow Latosols tend to stay in the homonymous class, while the former Red-Yellow Latosols are distributed in the classes of Yellow-, Red-, and Red-Yellow Latosols; otherwise the Una Latosols from the database were all classified as Yellow Latosols. In view of this, the lack of information about the color of the B horizon constituted

one of the main difficulties for updating the classification of these soils in the second categorical level. In this case, the taxonomic fitting was oriented by the previous name, with differentiation concerning the degree of confidence, according to the following pattern: Dusky Red- and Dark Red-Latosols were classified as Reds, and Yellow- and Brown-Latosols in the homonymous classes, all with degree 2 of confidence; similarly, the Red-Yellow Latosols were fitted in the class of the same denomination, but with degree 3 of confidence, due to the increased uncertainty of this adjustment.

In the third categorical level distinction, that is based on the characteristics of the exchange complex, in association with the contents of Fe_2O_3 from the sulfuric acid digestion, the taxonomic framework was very satisfactory as well as the subsequent level (subgroup), which seems to indicate major concern in the establishment of possible distinction of these soils, perhaps because of their high potential for agricultural use, as well as their large territorial expression in the country.

The word Latosol implies soils formed under conditions of significant weathering-leaching, resulting in materials with a residual concentration of secondary minerals, including kaolinite, gibbsite, and iron- and aluminum- oxides, in different proportions. The understanding of their genesis facilitates the identification of their corresponding names in the American Classification Soil Taxonomy and legend of WRB/FAO, as Oxisols and Ferralsols, respectively.

3.7 Luvisols

Grouping of soils characterized by the presence of textural B horizon or nitic B horizon, with high clay activity and high base saturation, excluding those with chernozemic A horizon. This class is represented in the database by 118 soil profiles (2.15% of the total).

Encompasses soils originally classified as Non-Calcic Brown soils and Red-Yellow Podzolic soils, with little participation of Gray-Brown Podzolic soils and Dark Red Podzolic soils.

It also includes some profiles formerly called Reddish Brunizens, whose A horizons do not have enough base saturation ($\geq 65\%$) to characterize the chernozemic A horizon, according to the current criteria.

Although having achieved a very satisfactory taxonomic fitting in the level of order, some loss of accuracy in the update was already observed from the second categorical level, as a function of the available data do not allow an precise evaluation of the dominance of colors of the B horizon, necessary to distinguish between Chromic- and Haplic- Luvisols. This fact resulted in a higher degree of uncertainty regarding the taxonomic fitting, also reflected in lower categorical levels. Another aspect that diffculted the classification of some soils, due to the unavailability of data for the entire extension of the profiles, is relative to the depth of the *solum* (horizons A + B), characteristic used to distinguish, in the third categorical level (great group), the class of Palic Chromic Luvisols.

For the same reason, the distinction of some soils in the fourth categorical level was also slightly affected, considering the utilized criteria to identify the classes of saprolithics and lithics. Moreover, some differential characteristics indicated in the previous denomination are not considered by the current classification, as the profile 58 of the soil survey of the State of Pernambuco (Brasil, 1972e), currently classified as planosolic Orthic Haplic Luvisol, in which the presence of solodic character and vertic characteristic expressed in the previous classification (solodic vertic planosolic Non-Calcic Brown soil), are not considered in the distinction of this type of soil in the current system.

The Luvisols can be framed in the class of Luvisols of the WRB/FAO legend, that presents the B horizon with accumulation of high activity clays. In the American classification the best correspondent classes of soils would be the Alfisols and Aridisols (Argids).

3.8 Neosols

Soils generally young, with little development and in process of formation, the Neosols are characterized by the absence of any diagnostic B horizon. With 684 soil profiles, that represent 12.48% of the database, are included in this class four major soil groups recognized by the classification scheme previously adopted in Brazil, that are the Litholic Soils, Regosols, Alluvial Soils and Quartzous Sands.

In close correspondence with the above groups four classes are recognized in the second categorical level: Litholic Neosols, Regolithic Neosols, Fluvic Neosols and Quartzarenic Neosols, all represented in the database. Because of this, as well as the close correlation of distinctive criteria adopted by the current classification system and the previous scheme, there were few profiles that presented some problems for taxonomic fitting in the suborder level.

In this sense, should be highlighted some soils previously classified as Litholic Soils, currently framed in the class of Regolithic Neosols, due to present the C horizon extending below 50 cm depth. However, some profiles of Quartzous Sands, might not even be fitted as Neosols, due to the change of the criteria adopted in distinguishing sandy soils, that from the 80's replaced the lower limit of 15% clay by the requirement of the granulometric compositions of the sandy and loamy sand textural classes. Consequently, the classification of these profiles was not updated.

The fitting of these soils in the third categorical level was also done without difficulty, in some cases guided by the previous classification, like some profiles of Hydromorphic Quartzous Sands for which the color of the subsuperficial horizon is not presented. However, the profiles AE9 and AE10 of the soil survey of the pilot area of Barreirinha-AM (EMBRAPA, 1982d), previously classified as solodic Ta Alic Alluvial Soils, that currently fit as Fluvic Neosols, could only be classified up to the second categorical level, because it is not included in the current system the distinction of soils of this class that present dystrophic character together with high activity clay. In this way, by correlation with similar soils, it is suggested the inclusion of the class of the Dystrophic Ta to the fitting of Fluvic Neosols in the third categorical level.

In relation to the fourth categorical level, in general, the distinction of the soils presented high agreement with the differentiations expressed in the previous denomination, although with certain degree of uncertainty in the taxonomic fitting, due to the absence of complete data of the profiles. For the profile P06 of the RADAM Brazil Project (Brasil, 1981c), it was not possible, however, the distinction regarding the occurrence of concretions, as indicated in the previous classification (concretionary Eutrophic Litholic Soil), characteristic that deserves to be evaluated as a differential characteristic of classes in the subgroup level.

The Quartzarenic Neosols updated in this database can be correlated with the Arenosols of the WRB/FAO legend, while in the American Soil Taxonomy this class would fit in the third categorical level (great group) as Quartzipsamments. Regolithic Neosols have been recognized as Regosols by WRB/FAO. Regarding their correlation with the American system this can be done only in the second categorical level (suborder) as Psamments. Soils that present lithic contact within 50 cm depth (Litholic Neosols), can be correlated to

Leptosols of the WRB/FAO legend. The American classification uses this property in the fourth categorical level (subgroup) and can be related to Lithic of Orthents suborder and also with Lithic of great group Psamments. The Fluvic Neosols are soils originated from alluvial sediments with close correlation with the Fluvisols of the WRB/FAO legend, while in the American Soil Taxonomy they would be fitted in the second categorical level as Fluvents.

3.9 Nitosols

In the database of soils of Brazil, this class is represented by 260 profiles, which equals to 4.75% of the total. Encompasses soils previously referred as Structured Dusky Red Earth, Structured Brown Earth, Similar Structured Dusky Red Earth and Similar Structured Brown Earth, beyond some profiles recognized as Red-Yellow Podzolic soils which present low textural gradient. More specifically for these last soils, there is a higher degree of uncertainty regarding the classification as Nitosols, because the database do not include information on morphological characteristics necessary for unambiguous identification of the nitic B horizon, distinctive of this class, whose requirements include structural development and significant presence of clay skins.

With the re-structuration promoted by the new version of SiBCS, regarding the inclusion of the class of Brown Nitosols in the second categorical level, many of the soils previously classified as Haplics, according to the first edition of the system (EMBRAPA, 1999), are now fitted in this new class.

In this work we option for the fitting as Brown Nitosols only the soils formerly called Structured Brown Earth or Similar Structured Brown Earth, provided they meet the requirement of specified color, or, in the absence of this information, assigning higher value for the degree of confidence (greater degree of uncertainty). This situation highlights the need for a more precise definition of the distinctive criteria of the class, where the comparison of related soils, members of the database under study could contribute. It should be registered also the impossibility of classification in lower categorical levels of the profile C48 of soil survey of the State of Paraná (EMBRAPA, 1984), originally identified as chernozemic A Eutrophic Structured Brown Earth, because in the current system classes that allow taxonomic fitting as Brown Nitosols with eutrophic character are not considered.

Relatively to other classes in the second categorical level, we observed a strong correspondence between the former Structured Dusky Red Earth and Red Nitosols, that beyond these soils also comprises a small proportion of Red-Yellow Podzolic soils. However, some soils previously recognized as Structured Dusky Red Earth, many of which having high iron oxide content, were classified as Haplic Nitosols, due to present 3.5YR or 4YR hues in the B horizon.

Regarding the fourth categorical level, as observed for other classes, some differences shown in the previous classification do not found correspondence which classes of the current system, such as the latosolic Eutrophic Similar Structured Dusky Red Earth (Brasil, 1982d), which fits as typic Eutrophic Haplic Nitosol. Also the profile C63 of the soil survey of the State of Paraná (EMBRAPA, 1984), previously classified as cambic Alic Similar Structured Brown Earth was fitted as typic Aluminic Brown Nitosol, for not being included possibilities of distinction relative to intermediate characteristics represented in the previous designation.

In this class are classified clayey to very clayey soils with slight increase of clay in the subsurface horizon, not establishing enough textural gradient for fitting as textural B horizon, but being possible to observe clear clay skins on soil aggregates. These observations can be found in the classes of the Nitisols, Lixisols and Alisols of the world soils legend of the FAO, while for the American classification Soil Taxonomy, it can be observed the correlation encompassing Ultisols, Oxisols (Kandic) and Alfisols.

3.10 Organosols

Due to the limited expressiveness of these soils in the country, generally restricted to small areas, as well as more difficult access, they tend to be contemplated with a few profiles sampled in more generalized pedological surveys as the ones considered here. Thus, the presence of the class of Organosols in the database was minimal, covering only 11 profiles, which equals to 0.20% of the total.

Characterized by its essentially organic constitution, the distinctive criteria of this class in order level present an adequate correlation with the set of soils previously included under the general denomination of Organic Soils. Thus, we obtained a very satisfactory taxonomic fitting in the highest categorical level, although for some profiles, considering the unavailability of complete data, the fitting in the current classification system has been performed by direct correlation with the previous classification.

For the subsequent categorical level, all profiles were classified as Haplics. Only for the profile 37 of RADAM Brazil Project (Brasil, 1981d), which presents very low values of pH in water in the subsurface horizon, there is about the possibility of occurrence of sulfuric horizon or sulfidric material (distinctive characteristics of Tiomorphic class), thus requiring more data for confirmation.

The main difficulty in upgrading the classification of these soils was observed in the third categorical level (great group), because the distinctive criteria involve determinations not performed in epochs before the publication of the first edition of the Brazilian System of Soil Classification (EMBRAPA, 1999), which makes very difficult a more accurate evaluation, even from complete morphological and analytical characterization of soils profiles. Classification at this level was therefore undertaken in an attempt form, fitting all the profiles in the class of Saprics, which groups soils constituted of organic material in an advanced stage of decomposition.

Also in the fourth categorical level, the absence of analytical data, especially concerning the electrical conductivity, reduces the confidence of taxonomic fitting. Only the profile C137 of the soil survey of the State of Paraná (EMBRAPA, 1984), referred in SiBCS (EMBRAPA, 2006) as representative of the terric Sapric Haplic Organosols, was classified with higher degree of confidence in all categorical levels.

Most organic constituents, in various stages of decomposition, in relation to the mineral ones are the basic criteria for the distinction of Organosols in the Brazilian system of classification and Histosols by the American system and FAO.

3.11 Planosols

In relation to the grouping of soils with planic B horizon, which is characterized by abrupt transition in association with sharp increase of clay in relation to the overlying horizon, the Planosols tend to occur in environments of restricted drainage, susceptible to hydromorphism at least temporarily. This class represents 4.22% of the updated of profiles

of the database, which is equivalent to 231 profiles. Refer to soils formerly called Planosols and Solodized-Solonetz, now included in the same class in the order level, distinguished in the second categorical level as Haplic Planosols and Natric Planosols, respectively. A very satisfactory adjustment between the classes previously recognized and the current ones was achieved.

However, despite the strong correlation between the current criteria for distinguishing these soils and the previously criteria used, because there are not available morphological data and analytical results of the entire profiles, some of them were classified based on the original name, such as the profile 66 of the technical bulletin 16, of the former Division of Research Pedologic (Brasil, 1972e), called weak A Ta Eutrophic Planosol, for which the subsurface horizon of the database refers to the C horizon, with no indication of the occurrence of colors having low chroma. Due to this, this soil was tentatively classified as typic Eutrophic Haplic Planosol.

The non-availability of analytical data also contributed for reducing the confidence of the update of the classification in the subsequent categorical levels. The distinction of Salic Soils, at the subgroup level, for example, was not possible, due to lack of data on electrical conductivity.

Major limitations for the taxonomic fitting were observed, however, in the fourth categorical level. For example, for the profile 89 of soil survey of the State of Ceará (Brasil, 1973a), originally called weak A vertic solodic Planosol, it was not possible with the available data, the confirmation of the solodic character, although it may be present in some horizon within the first 120 cm depth. Thus, this soil was classified as vertic Eutrophic Haplic Planosol. Similarly to observed for the other classes, some differential characteristics represented in the previous name are not included in the distinction of soils by the current system. As a result, the soil represented by the profile 200 of the RADAM Brazil Project (Brasil, 1981b), formerly designated plinthic Tb endoeutrophic Planosol, was classified as typic Eutrophic Haplic Planosol, because it is not included the plinthic class.

The soils that in the first edition of the Brazilian classification system (EMBRAPA, 1999) were differentiated in the second categorical level, such as Hydromorphic Planosols, were excluded from the current version (EMBRAPA, 2006). Actually they are classified as gleissolics in the fourth categorical level, but by the ordering of the classes in the identification key, in some cases they can not be distinguished as such. The profile 81 of the RADAM Brazil Project (Brasil, 1981a), for example, even though there are enough characteristics for its fitting as gleisolic, by the current criteria it is fitted as solodic Eutrophic Haplic Planosol, due to the solodic character take precedence in the distinction of soils at this level. As for the Dystrophic Haplic Planosols, the gleisolic class take precedence in relation to plinthic and solodic in the classification key at the fourth level, not allowing the distinction in the case of simultaneous occurrence of soils with these characteristics, as occurs for the profile 97 of the RADAM Brazil Project (Brasil, 1982b), originally classified as moderate A plinthic Tb Alic Planosol, by the current system fits as gleisolic Dystrophic Haplic Planosol. Considering the above comments, and considering the strong influence of hydromorphic conditions on sustainable use and management of these soils, as well as environmental and pedogenesis aspects, it is strongly suggested the distinction of Planosols with these characteristics in higher categorical level. This has practical application and considerable geographical expression mainly in the state of Rio

Grande do Sul (Costa et al., 2009). It seems appropriate to consider the possibility of keeping the distinction in the second categorical level, as adopted by the previous version of SiBCS (EMBRAPA, 1999).

The suborder of Natric Planosols can be identified in the American classification Soil Taxonomy and WRB/FAO as Natr-(ust-ud)-alf and Solonetz, respectively. Classes that do not fall into this suborder are denominated at second categorical level as Haplics and can be correlated with the classes of Planosols (WRB/FAO), and Albaquults, Albaqualfs and Plinthaqu (alf-ept-ox-ult)s of Soil Taxonomy.

3.12 Plinthosols

In this class are included soils characterized by expressive plinthization, presenting significant occurrence of plinthite, either in its mild or hard (petroplinthite) form, resulting from changes in the formation environment. In the database of soils of Brazil this class has a participation corresponding to 5.40%, which is equal to a total of 296 soil profiles. It covers the vast majority of the former Hydromorphic Laterites, which were later recognized as Plinthosols, a designation that was kept in the current system, and, with the modifications introduced in its latest version, referring to the concept of concretionary and lithoplastic horizon, now include those soils previously listed under the generic name of Concretionary Soils, including the Lateritic Concretionary Soils.

The main difficulty of current fitting of the soils in this class precisely refers to the last soils, which, because of the lack of more precise criteria for their identification, constituted a large and highly heterogeneous group. Thus, they were classified as Plinthosols according to the reference of the occurrence of concretions (petroplinthite) expressed in its name, giving high degree of confidence only for those soils with at least one horizon with 30 cm or more thickness and volume of pebbles and cobbles equals to 50% or more, enough for characterizing the concretionary horizon. For the others, considering that often the coarse material was discarded during sampling, or it was not measured, and the available data do not cover the entire extension of the profiles, it was considered greater uncertainty in the taxonomic fitting, with a moderate degree of confidence (value 2) in case there is some indication of the occurrence of petroplinthite (given by the horizon designation, for example), or lower degree of confidence (value 3), otherwise. All these soils, also including a smaller number of profiles originally called Concretionary Plinthosols or Concretionary Laterites, were grouped in a single class at second (Petric) and third categorical level (Concretionary), being distinguished only in the suborder level, due to the occurrence of some diagnostic horizon (incipient B or cambic B, latosolic B or textural B), or other differential characteristic, as mentioned in the previous name.

Other Plinthosols of the database were classified, in the second categorical level, as Argilluvics and Haplics, with great domain of the first in relation to the second ones. The change in the latest version of the system, referring to the argilluvic character (defined as having a texture ratio superior to 1.4) instead of the presence of textural B horizon to distinguish the Argilluvics (EMBRAPA, 2006), seems to be mainly responsible for this fact. In strong contraposition to the criteria adopted for Petric Plinthosols, the distinction of both classes in the subsequent categorical level is based on the saturation of exchange complex, and subsidiarily on clay activity for soils with very high aluminum content, differentiating soils with Alitic-, Alumic-, Dystraphic- or Eutrophic-character, all of these classes represented in the database.

Also in the fourth level it is clearly demonstrated the great difference in the criteria used in distinguishing between Argilluvic Plinthosols and Haplic Plinthosols, and the Petric Plinthosols, which constitute a very distinct group within this class.

The occurrence of appreciable amounts of plinthite in the soil profile is also identified in the class of the Plinthosols in the WRB/FAO international classification. The American system of classification adopts this character in lower categorical level (subgroup) and can be found correspondence of Plinthosols with different classes of the Soil Taxonomy, which present the plinthic character. These classes comprise the Oxisols, Ultisols, Alfisols, Entisols and Inceptisols.

3.13 Vertisols

The soils of this class, due to the dominance of very high activity clays, are characterized by a great capacity of swelling and shrinkage of soil material with wetting and drying cycles, a factor that restricts their pedogenetic development. Having little occurrence in Brazilian territory, Vertisols represent only 1.00% of the profiles in the database, comprising a total of 55 profiles.

As the identification of soils in this class includes criteria based on morphological characteristics evaluated in the field, the first categorical level was established by direct correlation with the original classification, whose name was maintained by the current system, just as the essence of the distinctive criteria, which allowed a satisfactory fit. For some profiles, however, there was some difficulty in taxonomic fitting, due to the presence, sometimes in the surface horizon, other times in subsurface horizon, of clay content below 300 g / kg, established as thresholds to distinguish the class of Vertisols (up to 20 cm depth, after mixing), but also for the vertic horizon (EMBRAPA, 2006). Once in the database are not included all the horizons of the profile, thereby preventing a more adequate evaluation, it was maintained their classification as Vertisols, assigning the value 2 for the degree of confidence in case of one of the horizons do not meet the specified requirement, and value 3 when both had amounts of clay below the minimum limit required. This situation, however, shows some discrepancy between the definitions of vertic horizon and of the class of Vertisols, as well as the need to adjust them. It may be appropriate to assess, from the characteristics of the profiles contained in the database, the adequacy of a minimum amount of clay established for distinction of these soils.

In the second categorical level, it were recognized classes of Hydromorphic Vertisols, Ebanic Vertisols and Haplic Vertisols. Some difficulty in classification was observed mainly for fitting of some soils as Hydromorphics, due to the subsurface horizons refer to depths greater than 50 cm, being necessary information on colors of the overlying horizons to confirm the classification (in this case it was assigned the value 2 to express the degree of confidence). Other profiles, on the other hand, did not present information on moist color, being classified as Haplics, with value 3 for the confidence degree.

Also in the great group level it was observed some difficulty in taxonomic fitting of the profiles, mainly due to the lack of relevant data, such as the contents of equivalent CaCO_3 . This form, the fitting in the class of the Carbonatics was based on previous classification, corroborated by the subordinated designation of horizons of the profile (EMBRAPA, 1988b), being the other profiles classified as Orthics, since the previous name did not present indication of the occurrence of salic character.

The absence of analytical data has hampered the taxonomic fitting in the fourth categorical level, as example of the electrical conductivity, necessary for the identification of saline character.

The characteristics of vertic horizon identify typical pedological features due to shrinkage and swelling of the minerals of this class. These features are called friction surfaces ("slickensides"), and are common both in the U.S. classification for the Vertisols as well as in the international legend of the FAO for those soils also called Vertisols.

4. Conclusions

The database used in this work reveals an adequate representativeness of the soil classes distributed over the Brazilian territory.

This database can function as an advance to stimulate the exchanging of information and experience among researchers at international level.

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