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THE UPPER ARAGUAIA BASIN AND THE EFFECTS OF HUMAN-INDUCED EROSION

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The upper basin

The Alto Araguaia hydrographic basin lies partially in the extreme south-west of the state of Goiás, Brazil, with a total area of 4,496 km², or rather, the sub-basin of the Araguaia River with 2,747 km² and the basin of the Babilônia River, its principal affluent, 1,749 km² and partially in the state of Mato Grosso (Fig. 1, 2).

The source of the Araguaia River lies near the Emas National Park (ENP) at two sites: Source A lies in the Fazenda Holândia in the municipality of Mineiros near the boundary of the two states; Source B lies in the Fazenda Link in the state of Mato Grosso.

Concerning the principal course of the Araguaia River, no exuberant flood plain is extant in the upper basin, as that due north, chiefly at middle course in a downstream direction with many beaches and forming important tourist resorts during the month of July.

Two of the main differences between the sub-basins of the Araguaia and the Babilônia Rivers are their discharge densities. Discharge is greater and soils are more clayey in the sub-basin of the Babilônia River (fig. 3), whereas in the Araguaia sub-basin soils are chiefly sandy.

The basin of the Araguaia River corresponds to the stretch in which the chief course of the Araguaia River and its affluents originate in the watershed plateau of the basin and of the Paraná-Paraguay basin. They flow and drain the terrain constituted of sedimentary rocks of the

LOCATION MAP: UPPER ARAGUAIA AND BABILÔNIA SUB-BASINS

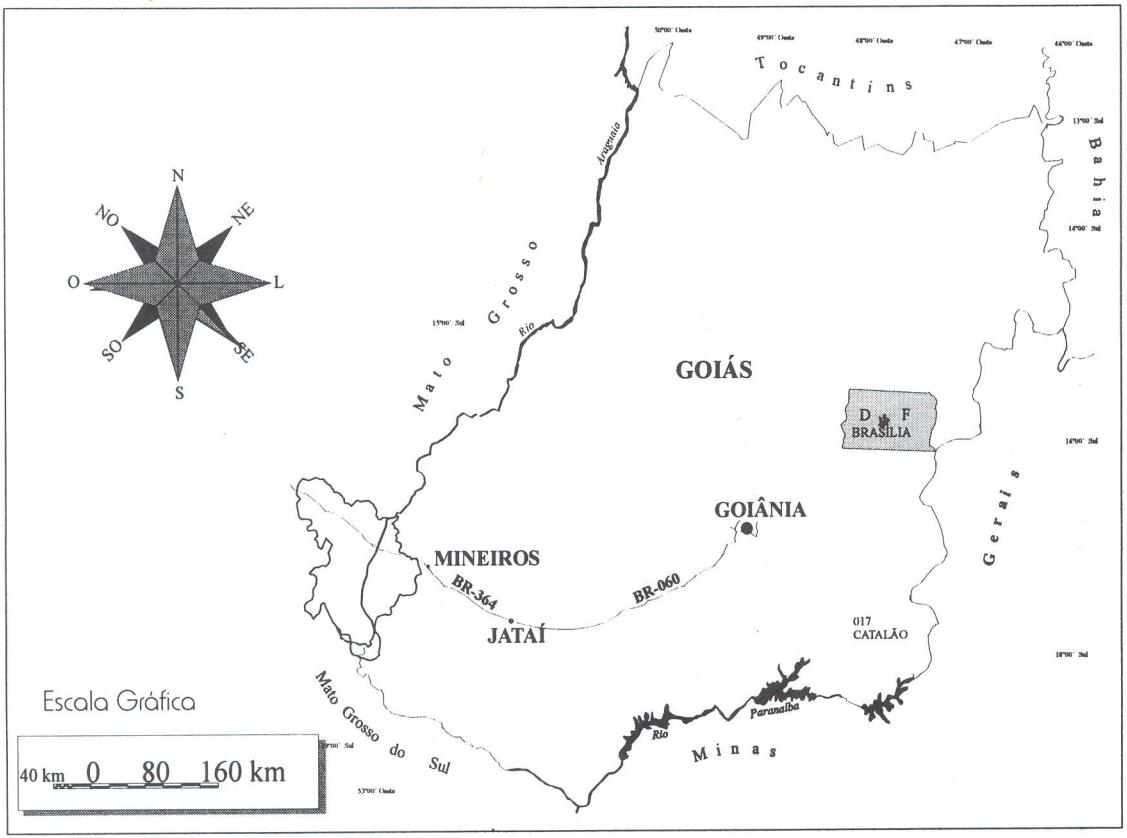


Figure 1

DRAINAGE MAP

Upper Araguaia and Babilônia Sub-basins

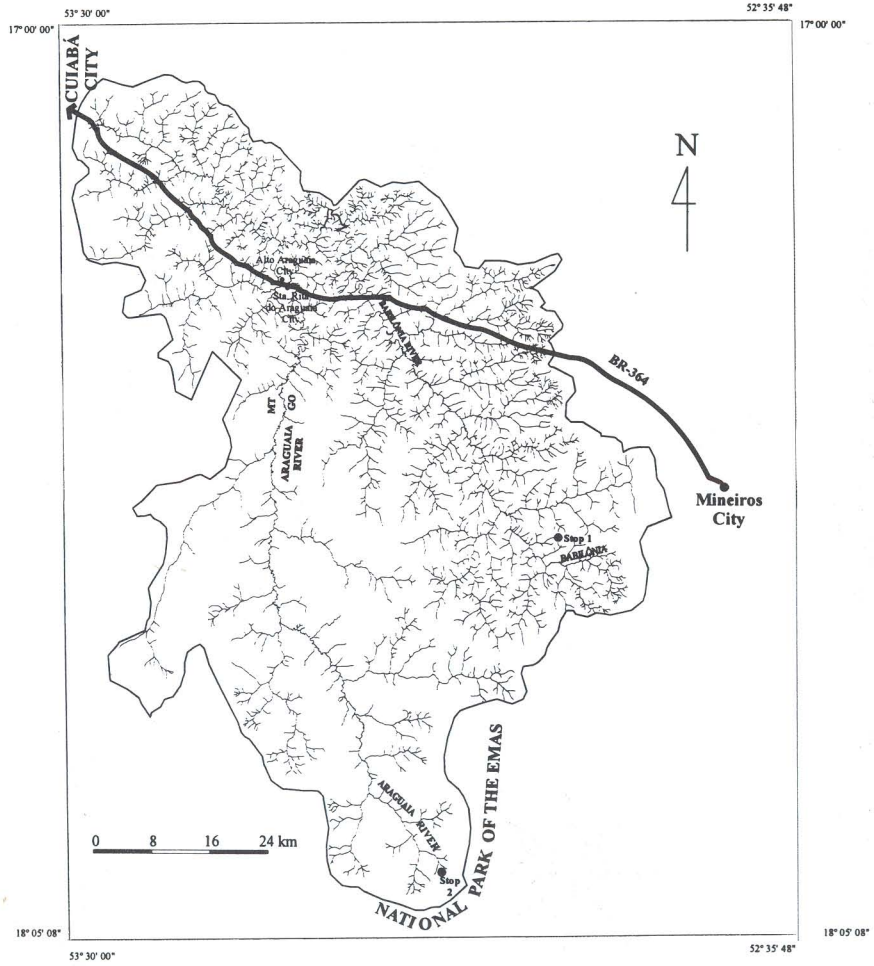


Figure 2

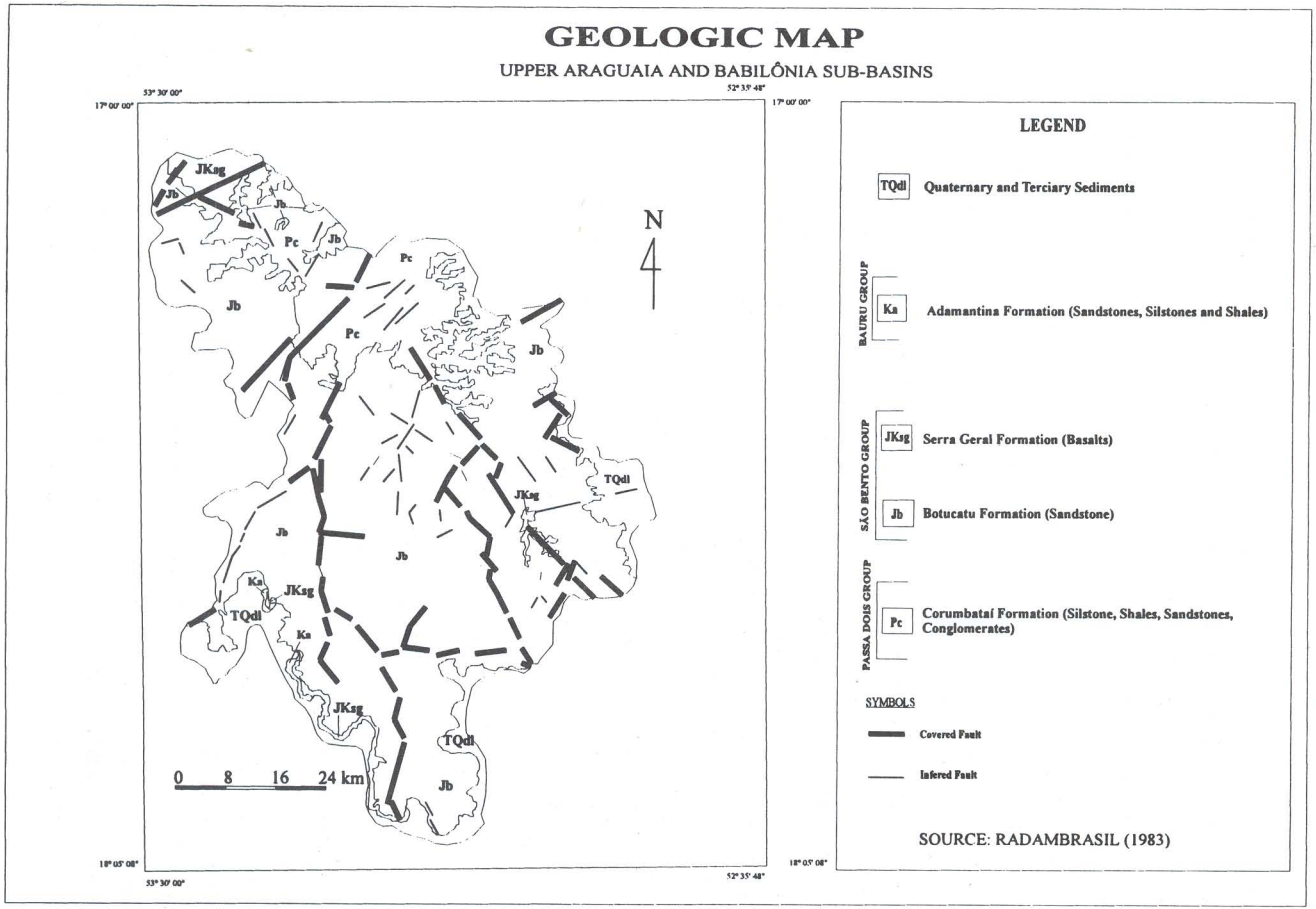

GEOLOGIC MAP
UPPER ARAGUAIA AND BABILÔNIA SUB-BASINS
53° 30' 00"
52° 35' 48"
17° 00' 00"
18° 05' 08"
N
JKsg
Jb
Pc
TQdl
Ka
0 8 16 24 km
LEGEND
TQdl Quaternary and Terciary Sediments
BAURU GROUP
Ka Adamantina Formation (Sandstones, Silstones and Shales)
SÃO BENTO GROUP
JKsg Serra Geral Formation (Basalts)
Jb Botucatu Formation (Sandstone)
PASSA DOIS GROUP
Pc Corumbataí Formation (Silstone, Shales, Sandstones, Conglomerates)
SYMBOLS
Covered Fault
Infered Fault
SOURCE: RADAMBRASIL (1983)

Figure 3

Sedimentary Basin of Paraná (chiefly Jurassic sandstones of the Botucatu Formation, sometimes crisscrossed by intrusive basalt rocks of Jurassic/Cretaceous period and covered by Tertiary/Quaternary detritus-laterite sediments at the peak of the plateau or of its remaining hillocks) (figure 3).

There are three geomorphologic compartments in the upper basin: 1) flat upper compartment with extensive peaks associated with Tertiary detritus-laterite covers and altitudes over 850 m; 2) dissected lower compartment predominantly developed on rocks of the Botucatu Formation and characterized by wide and mild convex slopes associated with flat bottom fluvial valleys. They are frequently filled with alluvial and colluvial sediments ranging between 600 and 700 m and harboring the sources of the Araguaia River and its principal tributaries; 3) intermediary compartment associated with an acclivity limiting the both previous compartments (figure 4).

Vegetation that previously covered the basin corresponded to the tropical savanna divided into various subtypes (savanna, open savanna, wooded country, unwooded country and woods). Deforestation is present almost throughout the entire basin, with the exception of PNE and substituted by intensive soy bean plantations, heavily mechanized in the plateau, by pasture and subsistence culture in the lower part.

Soils and soil susceptibility

Two great types of soils occur in the basin: (1) dark red latosoils of clayey to average texture, with high acidity, widely dominant on the plateaus and their hillocks, which pervade all the hilly terrains of the sub-basin of the Babilônia River and correspond to about 44% of the area; (2) quartz sands, sandy, thick, with high acidity, with approximately 40% of the basin's total area, predominant in the sub-basin of the Araguaia River, hydromorphic in valley bottoms. To the N and NW of the basin there are smaller occurrences of other types of soil, such as Red-Yellow

Podzolic and Latosoil Structured Red Soils ("Terra Roxa"), both associated with occurrence of fine rocks of the Curumbataí Formation (siltstones, shales, fine etc) (figure 5).

When the substratum is correlated with the soils in morphopedological compartimentation , albeit greatly generalized, two great compartments are dominant and reproduce the above: XII (arenite Botucatu, with less dissected forms of the lower section and predominance of quartz sands) extends itself to almost all the Araguaia sub-basin and XI (arenite Botucatu, with more dissected hill formations and dark red latisols of average texture) of the sub-basin of the Babilônia River.

These characteristics classify erosion susceptibility of this type (Fig. 6), in which compartments correspond to extremely to slightly susceptible class, respectively. The latter is extremely susceptible at the sloping margins of table-shaped reliefs and in the area with Podzolics occurrence.

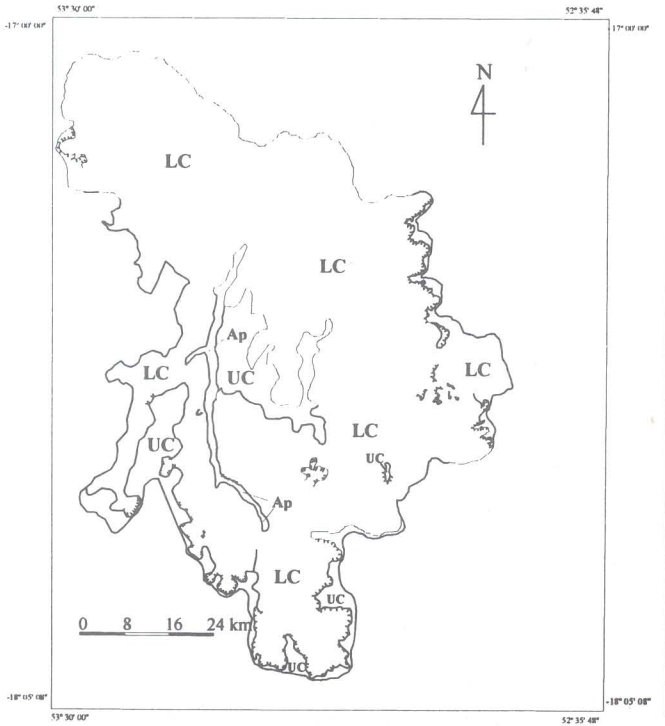
Erosion features

In Brazil the most active gullies are caused by disturbances of vegetation and inappropriate use of soil. The presence of thick soils or saprolites favor the development of fluvial erosion. Active and well-developed gullies are called "voçoroca" and "ravina". The occurrence of linear type erosions ("ravina" and "voçoroca") has been confirmed in the entire basin and especially in the sub-basin of the Araguaia. More than 70 serious occurrences have been registered and associated with dominant sandy soils (Fig. 5), even though declivity is slight.

According to research in the sub-basin of the Araguaia, the erosion phenomenon has been partially attributed to the natural susceptibility of soils. It is largely due to generalized deforestation and refusal to comply with environmental legislation, especially when it refers to permanent reserve areas (sources, drainage heads and riparian vegetation) and to

GEOMORPHOLOGIC MAP

ALTO ARAGUAIA AND BABILÔNIA SUB-BASINS



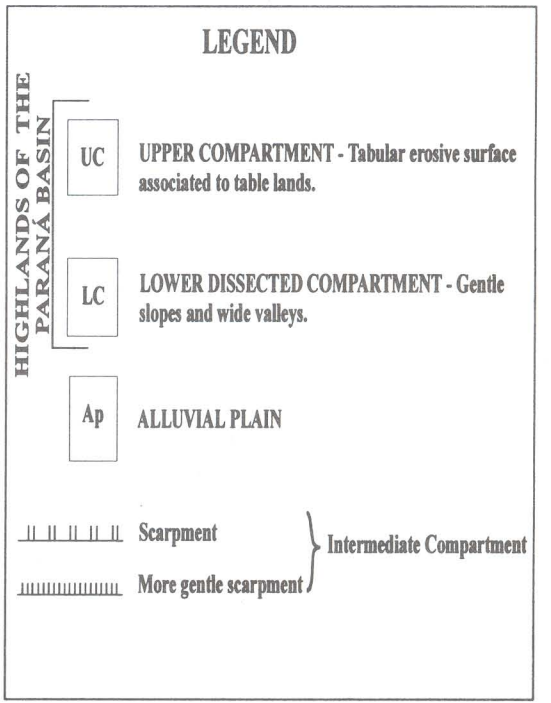


Figure 4

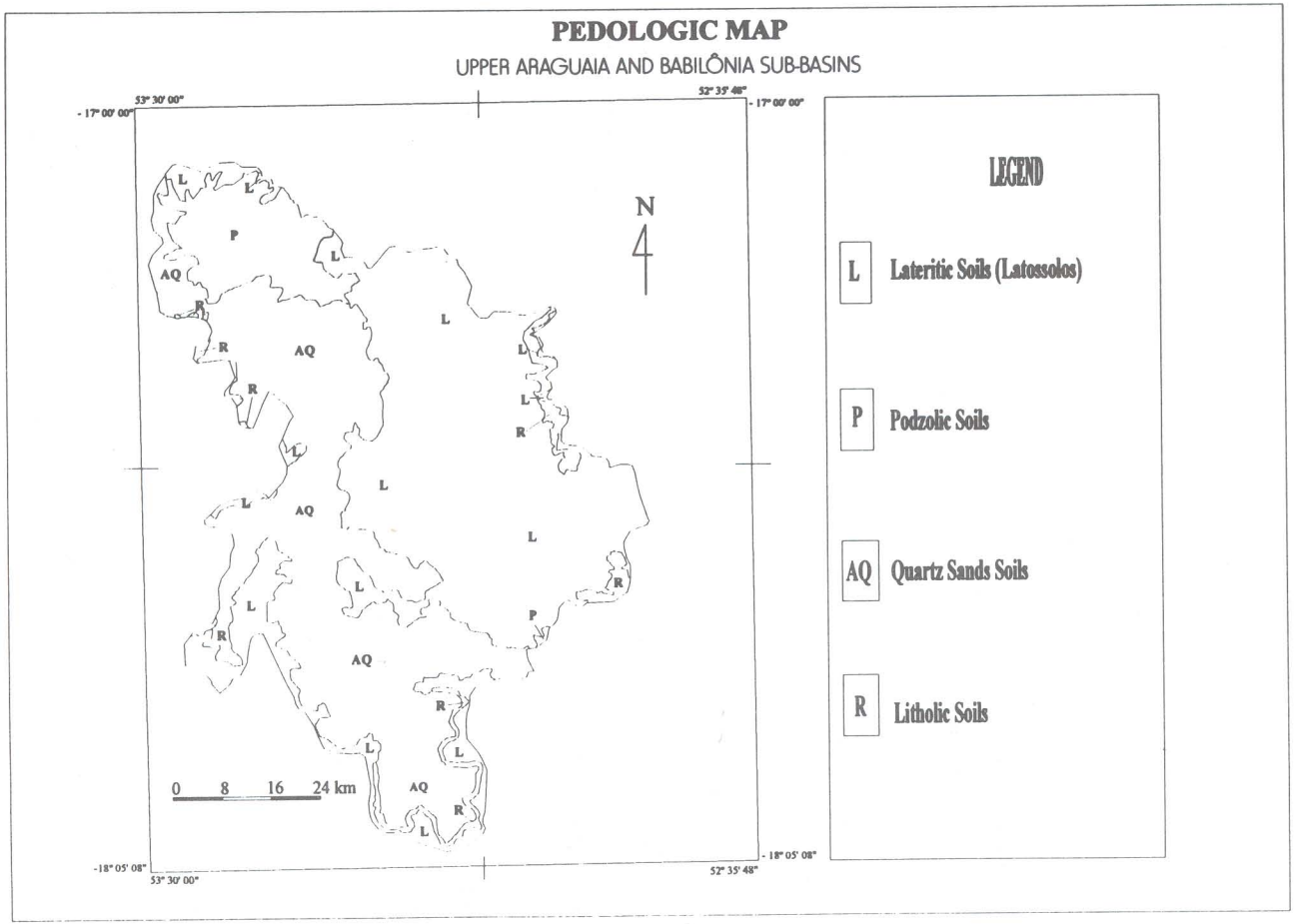

PEDOLOGIC MAP
UPPER ARAGUAIA AND BABILÔNIA SUB-BASINS
53° 30' 00"
52° 35' 48"
- 17° 00' 00"
- 18° 05' 08"
N
0 8 16 24 km
LEGEND
L Lateritic Soils (Latossolos)
P Podzolic Soils
AQ Quartz Sands Soils
R Litholic Soils

Figure 5

legal reserves with improper conservation practices or their sheer absence. As a result silting in the valley bottoms occurs, chiefly in the Araguaia River. The contribution of silting for the entire basin is still difficult to evaluate.

Environmental campaigns and emergency measures to contain silting advance have been undertaken by government and non-government organizations and even by the local farmers. However, a true solution is difficult to find. Not only emergency attitudes should be taken into account but middle and long term measures should be employed such as those of a sustainable technical-conservation character and even social ones linked to environmental education involving institutions and the community in general.

Visiting points

In two halting points we shall visit two erosion occurrences, "voçoroca" type of the hydrographical sub-basin of the rivers Araguaia and Babilônia. A panoptical survey and a visit to the sites will be planned.

First point – Chitolina erosion: River Babilônia (source: FEMAGO, 1998, adapted)

Site: Fazenda Chitolina, municipality of Mineiros GO Brazil.
Routes: GO 341, Km 8 some 14 km from secondary road.
Characteristics:

Geology: sandstones of the Botucatu Formation;
Soils: quartz sands.

Geomorphology: long gentle slopes passing progressively to plateau; "voçoroca" is perpendicular to drainage axis and slightly oblique to axis of descending slope; it has a main axis and a lateral branch and

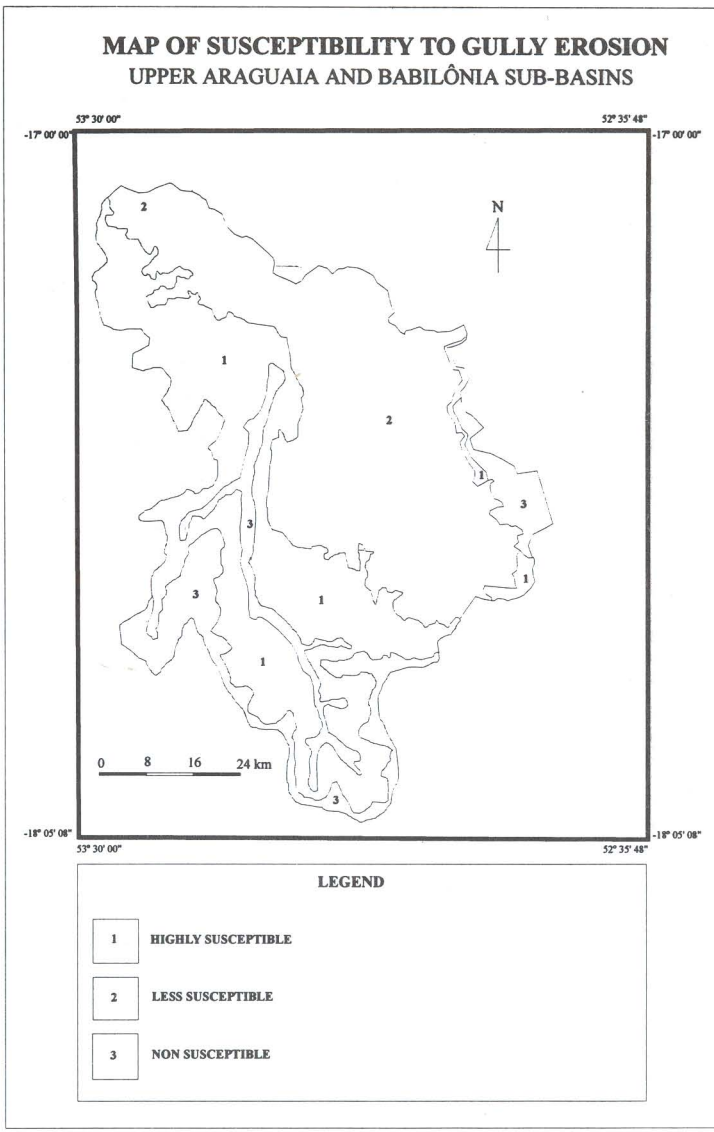

MAP OF SUSCEPTIBILITY TO GULLY EROSION
UPPER ARAGUAIA AND BABILÔNIA SUB-BASINS
53° 30' 00"
52° 35' 48"
-17° 00' 00"
-18° 05' 08"
N
0 8 16 24 km
LEGEND
1 HIGHLY SUSCEPTIBLE
2 LESS SUSCEPTIBLE
3 NON SUSCEPTIBLE

Figure 6

traceries on the right side with sharp asymmetry between inclinations. The right side has more declivity. Inclinations are unstable and high at the head and in the middle stretch, with washouts associated with piping. Final stretch has a wide bottom trapezoid section, low inclinations followed by shallow silting which covers organic soil with river deviation. Diffusion is covered by grassland with terracing on both sides and interrupted upstream by erosion. Surveyed stretches (1998) have the following measurements: head stretch: 23 m high; middle stretch: 16 m high; final stretch: 8 m high.

Dynamic: a road along the valley, with hedges, side entries without accumulation basin, favors the flow of surface waters through cattle paths and drains in the "voçoroca"; extremely active head, swift, regressive and slower enlargement in the middle stretch, relatively braked by terraces; relatively accommodated silting with swamp vegetation.

Control: diffusion type: entries with infiltration basins along the road, re-dimensioning of terraces, re-vegetation of erosion contours (100 m), isolation of area; in the "voçoroca": drainage of ground water, reconstruction of slopes and planting of vegetation in the valley bottom and silting area.

Second Point - Water Source A - Araguaia River

Site: Fazenda Babilônia, municipality of Mineiros GO Brazil.
Route: GO 341, some 80 km from town, 7.5 km of dirt road, passing through the middle of the plantation.
Characteristics:

Geology: sandstones of Botucatu Formation.
Soils: Quartz sands.

Geomorphology: two sections: the first is in the plateau slope with circular ravines aligned to the "voçoroca" axis with sliding; the second

lies in the lower part, some 450 m from the previous one and corresponds to the "voçoroca" itself, with a single axis, initial measurements (1998) amounted to: length: some 250 m; width: approximately 25 m; average depth: 9.0 m; volume: 46,282 m^3.

Vegetation: original and intruding vegetation in the lower section of the axis and remains of woodland near the left slope, partially damaged.

Diffusion: contribution basin with approximately 10% declivity, terracing over quartz sands with annual cultures, with mild to low agriculture technology.

Dynamic: concentration of rain surface water draining from the plateau towards the headwater; formation of ravines due to interception of ground water and appearance of welling, with liquefaction and sliding of slopes and, as a consequence, widening and silting of base.

Control: dikes; central and side drains; soil replacement; replanting of vegetation; reformation of basin, extermination of ants, clearing and isolation of "voçoroca"; management of surface water by better terracing in area of contribution, reforestation of the plateau borders.

Third Point: visit to the Emas National Park. Meeting with local technicians.