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Figueira de Carvalho, Ricardo

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EVALUATION OF THE LOSS OF SOILS IN THE BASIN OF RIBEIRÃO SERRA AZUL AND THE DEPOSITION OF SEDIMENTS IN THE RESERVOIR OF THE COMPANY OF SANITATION OF MINAS GERAIS-COPASA

Ricardo Figueira de Carvalho/Consultor Ambiental
ricardof@uai.com.br

INTRODUCTION

The choice of a supplying spring should consider, not only you factor as distance of the consuming center, readiness of flows, but also the use form and occupation of the soil of a hydrographic basin.

The area object of this work, the basin of Ribeirão Serra Azul, when of the planning adopted to that time for choice of the spring, final of the decade of 70, it counted not only with I aid him of countless organs in different spheres of decisions, but in the innovation in preserving the atmosphere as a result of the first external pressures of the agents backers.

On this first moment the Company of Sanitation of Minas General-COPASA, gave an important step in the environmental subject in the State of Minas Gerais, promoting the mitigation of the current impacts of the stage of construction of the reservoir and investing in the preservation of his/her patrimony and spring.

As spring supplying of water for great part of the Metropolitan Area of Belo Horizonte-RMBH, the studies regarding the contribution of sediments, the expectation of useful life of the reservoir, they are important parameters to check the validity of an applied foreign methodology in our country, as still, and mainly, to verify the evolution of the quality of the made available water and produced by COPASA-MG, relating with the evolution of the use and occupation of the soil in the same basin.

Ribeirão Serra Azul, belonging to the sub-basin of the river Paraopeba and tributary of River São Francisco, is main one hydrological study, whose nascent they are in the quota altimétrica

of 1.300m, in the group of mountains that takes the same name, specifically the Serra de Itatiaiuçu.

Including a total area of 256 km2, that basin interferes in the municipal districts of Juatuba, Mateus Leme, Igarapé and a small part of Itaúna, being the bus axis in the first mentioned municipal district.

The first environmental studies were still accomplished in begin of the decade of 80, where the basic tool was the interpretation of aerial pictures in the scale of 1:25.000, base for elaboration of self-explanatory maps for the themes: Geology; Steepness; Permeability of the Soils; Vegetation and Potential of Erosion.

Later, in 1992, it was elaborated by the Foundation Technological Center of Minas General-CETEC, a new map of the basin of Ribeirão Serra Azul starting from picture-interpretation being used aerial pictures in the scale of 1: 30.000 of the flights CEMIG 1989, this for the whole basin, and of the flight COPASA 1998, climbs 1: 30.000 just covering the area of direct contribution and I spill to the reservoir.

The works developed in the basin of Ribeirão Serra Azul

This work was elaborated starting from extracted data of the Dissertation of Master's degree entitled for "Evaluation of the Use and Occupation of the Soil in the Basin of Ribeirão Serra Azul and the Consequences in the Reservoir of Provisioning of COPASA-MG", presented the Institute of Geosciences of UFMG close to, in junho/2002, this that approached the whole problem of a basin in general work destined to the domestic-industrial provisioning of a great population area, in this case the Metropolitan Area of Belo Horizonte-RMBH.

So that if they obtained results, they were made studies adapting and applying the Universal Equation of Losses of Soils (Equation of Wischmeir). Tried to obtain data to esteem the useful life of this reservoir, giving like this conditions to plan the prolongation of operation of this reservoir.

Parallel, it was made a maping of the whole basin, this in 1983, repeated work in 1992 and 2001, when the evolutions were considered in the form of to use and to occupy the urban and

rural space, to features of the relief, the progress and move back from the vegetable covering, among other aspects.

During the works accomplished in 2002, they were still made analyses physiochemical of the sediments docked in the reservoir, rising and attendance of 28 sections implanted in that body hídrico, application of the methodology of GPR (Ground Pennetrating Radar), rising and distribution of the fishes communities in the whole lake and the updating of the map of the basin that refer on the use and occupation of soil.

METHODOLOGY

Applied Models in the Basin of Ribeirão serra Azul

Universal equation of Losses of Soil-Wischeimeir

In the decade of 60, Wischmeier and Smith began the development of a mathematical modelling, ending for the elaboration of the Universal Equation of Losses of Soil-USLE.

In the year of 1983, COPASA-MG looking for instruments to subsidize a better administration of the basin of Ribeirão Serra Azul, specific environmental studies were elaborated in this area, among them the application of the model previously mentioned.

This equation is given by the formula below described:

E= 2.24 (R) (K) (L) (S) (C) (P) where,

E= annual loss of soils in ton/ha;
2.24 = constant to transform in metric unit;
R = index of rain drainage given by the geographical location;
K = erosion factor of the soil;
L = factor topographical length of the slope;
S = factor topographical steepness of the slope in%;
C = factor of handling cultures;
P = practical factor of erosion control.

Model of Deliberation of Sediments in Reservoir-Roehl (1962)

The deliberation of sediments consists of the action in determining the percentile volume of solids that you/they are thrown in the rivers after desegregation of the consolidated feature, be a rock or a soil.

After many studies some authors developed several models in this field, having been applied for the area the following:

Log D = 4,5-0,23 log 10W-0,5 L/R-2,79 log B, where:

D = percentage of deliberate sediments in certain area;
W = drainage area in square miles;
L = length of the main channel;
R = larger share elevation of the basin subtracted the share of the mirror of water of the reservoir;
B = proportional average of bifurcation, that is, the number of channels of any order divided by the number of channels of a superior order.

Model of Deposition of Sediments in Reservoir-Ackerman and Corinth (1962):

The deposition of sediments in dammed areas and rivers correspond to an inferior value to the volumes that were produced and deliberate.

Ackerman and Corinth (1962) they elaborated a model to evaluate these volumes, arriving the following expression:

$$P = 0{,}43\ ET\ \frac{I^{1/3}\ S^{1/2}}{F^{3/4}}$$ where,

P = sediment deposited in the reservoir in ton/acre/year;
E = erosion total to amount in ton/acre/year;
T = percentile total of sediments transported in channels in the direction of the reservoir;

I = reason between the medium annual flow total and the surface of the last foot of water of the reservoir;
F = proportional dimensions among the length of the equivalent main channel to the diameter of the basin (the diameter of the basin is equivalent to the diameter of a circle of same area);
S = medium inclination of the channels of first order, less the medium inclination of the channels of second order.

The reasons in relating the ictiofauna and the contribution of sediments in the reservoir Serra Azul.

The reservoir of Serra Azul has been affected along more than two decades by a considerable volume of sediments that you/they are produced partly in a natural way, but mainly for a liability in great volume that the mining actions left in the past.

The own vocation of the area in the cultivation activity does with that countless areas are permanent sources in the production of substantial volumes of materials particulates, being always disposed to the transport.

In the specific case of the reservoir of Serra Azul they were found several atmospheres, being: slow area with high exhibition to the solar light; slow area with low exhibition to the solar light; slow area with high exhibition to the solar light and little bottom sediment; slow area with low exhibition to the solar light and little bottom sediment; slow area with high exhibition to the solar light and great contribution of bottom sediment; slow area with low exhibition to the solar light and great contribution of bottom sediment;

Like this, the area in study is constituted actually in a big one and potential research laboratory by the following reasons: the) relative diversity of atmospheres to the contribution of sediments; b) relative diversity of atmospheres to the conditions limnologists of the waters; c) the varied use forms and occupation of the soils conditioning possible interferences in the local fishes communities ; c) great readiness of nutrients close to the carted sediments or dissolved in the waters that can be contributing in the largest or smaller development of some species of fish; d) for being a reservoir of private use and, consequently, submitted to a rigid control of his/her use internal, such situation can create exceptional conditions in the development of the species of fish.

RESULTS AND DISCUSSION

Species of the fishes captured in the reservoir of Stream of Serra Azul Dam .

After the accomplishment of 4 sampling campaigns, they were lifted up the following species of the fishes that occur in the Serra Azul Reservoir:

Exótics Species: *Cyprinus carpio* (Carpa); *Clarias gariepinus* (Bagre Africano); *Cichla ocellaris* (Tucunaré); *Oreochromis niloticus* (Tilápia); *Hoplias lacerdae* (Trairão do Amazonas); *Colossoma macropomum* (Tambaqui); *Pseudoplatystoma sp.* (Surubim híbrido)
Natives Species: *Astyanax fasciatus* (Lambari do Rabo Vermelho); *Astyanax bimaculatus* (Lambari do Rabo Amarelo); *Hoplias malabaricus* (Traíra); *Salminus hilarii* (Tabarana). *Geophagus brasiliensis* (Acará); *Hypostomus sp.*(Cascudo); *Leporinus macrophthalmus (piau-açu)*; *Prochilodus lineatus* (Curimatã); *Rhamdia quelen* (bagre).

Analysis of the evolution of the use and occupation of the soil in the basin of Ribeirão Serra Azul

The three mappings of the basin were elaborated with visions and different connotations one of the other ones regarding the object the classified being and mapped. Like this, in the assembly of the comparative picture some spaces were in open due to different correlations among the parameters.

For the field-savannah formation a gradual fall can be observed in the busy area of 70,0 km2 in 83 for 57,7 in 94 and 46,9 km2 in 2000. These areas were given up for expansion partly the agricultural section with new fronts of pastures and cultivation areas and still in more reduced portion for enlargement of the urban areas.

For the portions of exposed soils it happened an area reduction, much more in the form of interpreting the mapping, that in the field reality. Important È to emphasize that having been the mapping accomplished in times and different periods, that that it would be an exposed soil in one occasion, in other, even with years of difference, it could be covered, once the area is basically of perennial cultures.

The areas destined to reforestations also had a sensitive reduction so much in surface as in percentile busy. This i probably due to the following facts of the great portions be located in areas that they were dispossessed by COPASA, being, later, suppressed or busy goes recovered native formations; the motivates lack goes new fronts of reforestations in the decade of 80 with the implantation of the great area of special protection that it was the reservation of COPASA; to the incentive also in the opening of new projects front to the economical crisis that it devastated the country in that period, worsened by the competition of the cheaper coal produced in larger scale in the north of the state.

Unlike the reforestation, it was possible to observe an increase of the busy area for a denser vegetation, so much in area as in percentile of the basin, fact that is due, certainly, the politics preservationist implemented starting from that time, mainly in that area. To this fact it is also added every reforestation with native species that COPASA introduced in the areas of his/her property.

Relative to the busy area for dams and dams, this also had a small increase that is due to the expansion of a new leisure activity that you/they are the "fish-and-pays." This activity is promoting a significant alteration in the communities of fish of the reservoir.

The urban portions also had a significant growth in the last 20 years in function of the expansion of RMBH. Several they were the divisions into lots registered to the long of that work in residential areas and another destined to the leisure.

It was also observed an expansion of the urban perimeter in the municipal districts of Igarapé and Mateus Leme, where there was an increase not only of areas of the municipal thirst of the first mentioned, as still of the district of Serra Azul, this belonging to the second mentioned municipal district. These areas, according to the mapping, passed of 1,1 km^2 in 1983, for 15,55 km2 in 2000.

Analysis of the Evolution of the Occupation of the Soil X Contribution of Sediments.

The basin of Ribeirão Serra Azul, even before the implantation of the reservoir, it was always considered extremely problem should be located in the same a great group of activities that by itself are highly impact to the environment.

The mining's of iron, the agricultural border of products destined to a great urban center, and an area of real estate expansion, they are reasons sufficiently endowed with concerns for the area.

These several activities distributed by the whole basin, some punctuate, another of wide spectrum, were and they are still of great relevance when a comparative study of their interferences is promoted with the located contribution of sediments in the Reservoir of Serra Azul

The fact of already to exist, as already mentioned along the work, a great liability of sediments originating from of mining's and these dispersed and prone the they be transported, they do of the whole sub-basin that arrives to the arm of Ribeirão Serra Azul the more committed among all the another that it composes the group.

To this fact the can also be added larger area, where proportionally they are located the largest percentile of exposed soils that together to the mining rejects, they already carted to the reservoir significant volumes of solids, committing partly some areas of that hydrological course.

The contributory arms of Diogo's River together with the Stream of the Stowage, they form an area also very representative in the proximities of the Solar Condominium. Regarding the sand full of part of the reservoir, this happens in proportions very different from the area drained by the Blue Mountain.

In a third group when the sand full degree is compared, they are the arms of the Streams of Potreiro, Curralinho, and Jacu. The streams, all with areas of internal and external drainages those of property of COPASA, receive a reasonable volume of sediment, whose larger part if it owes to the actions practiced in lands of third.

Last, we have the group of basins of direct contribution to the reservoir, where the small contribution of sediments is related not only the small drainage area corresponding to each a, as well as the wide vegetable covering that protects the soil and him/it almost total control of erosive focuses for COPASA. Only in the streams, anoint the socket of water, it is that an erosive focus is going taking great proportions and committing that area in function of a mistaken deviation of pluvial drainage in the COPASA area.

Finally, it should be explained that to the contribution of sediments of the whole basin, they are related the several erosive focuses of larger load than in the past they had an important paper in the determination of accomplishing deeper studies for the area.

These gullies distributed so much in areas that were acquired for COPASA, as in another located in private lands, they passed in these last ones almost 20 years for a process of natural recovery, with little or almost any human interference.

These focuses that produced in the past and they deposed great volumes of particles in the slopes of the contributory arms, today they are scars almost that imperceptible in the relief of the area.

For right some of these gullies would have appeared in the past in function of the alteration in the sheet promoted by the stuffing of the reservoir. In the course of time and, consequently, the stabilization of the base level in new landings, began a process of regression of the erosive activities then until then active.

Analysis of Fishes Communities X Basins Contributory X Contribution of Sediments

The distribution of the fishes communities for the whole Reservoir Serra Azul expected direct relationships and proportions maintained so much with the load of the contributory tributaries, as for the volume of carted material and deposited in the reservoir.

Some of the species had low occurrence in function of the capture of only one time, as it was the case of the *Hypostomus sp*. (cascudo*)*; *Colossoma macropomum (*tambaqui*)* and *Pseudoplatystoma sp*. *(*surubim híbrido*).* These two last collected in Diogo's Braço Ribeirão, receiving area of drainage originating from of the main establishments of "fish-pays."

The other species were distributed in an expected way by the whole lake, observing, evidently, the relationship of their alimentary habits with the different atmospheres of the reservoir.

Like this, species typically predators as the *Salminus hilarii (*tabarana*),* they were captured, preferentially, in more limpid and deep waters where there was larger food readiness as the *Astyanax fasciatus (*Lambari do Rabo Vermelho*)* and the *Astyanax bimaculatus (*Lambari do Rabo Amarelo*).*

Other species as the *Cyprinus carpio (*Carp*a),* the *Prochilodus lineatus (*curimatã*)* and the *Clarias gariepinus (*Bagre Africano*)*, they had their linked location on the arms with larger volume of sediments deposited. Those areas presented domain of species wide alimentary preference.

A third group corresponds to those species typically predators as they are the cases of the *Hoplias lacerdae (*Trairão do Amazonas*)*; *Hoplias malabaricus* (Traíra*)* and *Cichla ocellaris. (*Tucunaré*)* that are thoroughly distributed by all streams.

A last group fishes is formed by the species *Astyanax fasciatus (*Lambari do Rabo Vermelho*)*; *Astyanax bimaculatus (*Lambari do Rabo Amarelo*); Geophagus brasiliensis (*Acará*)* and *Oreochromis niloticus (*Tilápia*)* with wide occurrence and reproduction for the whole lake. These species also possess a wide diversity of alimentary habits, being this the main reason that it is justifying their expansion for the Reservoir Serra Azul.

Relative to the distribution for corporal weight, it was also verified a narrow relationship between the biomass and the dimensions in the capture place and in the contribution of sediments.

In the arms with larger sedimentary load, Ribeirão Serra Azul, Ribeirão Diogo and Stream of Jacu, they were listed the largest relative values of individuals, respectively, 174, 78 and 128, and the also the largest corporal weights, 186,119 and 67 kg.

In the taxpayers whose drainage basin keeps the best and more preserved natural characteristics, obviously the load and contribution of sediments were always much reduced if compared to other areas. In these places as, for instance, in the streams A and B, in the Streams of the Capivaras and of the Lobo respectively, so much the number of captured individuals, as the weight corporal total was very reduced if compared to the group previously mentioned, respectively, 20,12,12 and 7, for a total weight of 11; 7; 8; and 6 kg.

Among these groups he/she appears a third party and middleman formed by the taxpayers Flowing of the Swamp, Stream of the Swamp, Area of Reforestation, Stream of the Stowage, Stream of Potreiro and Stream of Curralinho. In these areas, whose characteristics are similar, the number of captured individuals varied between 40 and 50 copies, with total medium 16,2 and 28,5 kg of corporal weight.

CONCLUSION

For the subjects related to the ictiofaunistic of the Reservoir of Serra Azul, after the accomplished samplings and identification of some specific uses of occupation of the soils, it was ended that:

- The reservoir of Serra Azul is constituted in of native species of fish to the basin, as well as of exotic species of fish;
- In function of the great accumulation of sediments in some areas of the reservoir, together with the location of leisure establishments in drained areas of this sub-basins, he/she settled down at these places that the registered ictiofaunistics is very established in the whole lake face to the cash control process and fiscalization exercised by the surveillance of COPASA;
- As for the use and occupation of the soil in the basin of Ribeirão Serra Azul, it is possible to end that in this subsequent period to the I begin of operation of the reservoir, they happened significant alterations in the form of occupying the space, could be outstanding: the areas explored by the activities mining had a small relative increase of his/her surface, having happened an deep of their plowings actually;
- Before the exposed, the existent relationship was verified among the species of IctiofaunisticX Basin contributory X Contribution of sediments, where the volume of

sediments and the load of carted nutrients can interfere, on time, in areas different from the reservoir.

Final considerations

- Even with some deficiencies in the process of fiscalization of the areas of property of the company of sanitation, these actions are shown of great importance in the maintenance of that reservation's environmental patrimony;
- The lake has as registration of the ictiofaunistics the presence of native species as tabarana, piauçu, curimatã. It is known that those species only reproduce in atmospheres rivers, rapids. With the presence of those native species migradoras in that lake (atmospheres) during a cycle complete hydrologic, suggests himself new studies with detachments of the reproductive cycle of those species in the studied reservoir;
- If made a comparison among the mining processes tends as mark the stuffing of the Reservoir of Serra Azul, two very different phases will be observed, in other words, a first one where there was not any concern with the environmental and other, subsequent subject, where the constituted power and the organized civil society look for to rescue a form of promoting a sustained development. One cannot stop emphasizing that the problems happened in the past will still leave a lot of sequels for the present and future of the basin; also the urban areas in the basin suffered a relative increase, considering in this period the alterations in the perimeter that you/they limit these with the rural ones. This increase was very smaller observed the perspectives of the past; the areas covered by vegetable formations if they maintained in similar total values, this in face of small expansion of the agricultural activities in the basin. As novas frentes abertas neste setor foram compensadas em parte pelas áreas adquiridas e transformadas em reserva pela COPASA;
- It is possible to affirm that the innovative measures implemented in the past when of the stuffing of the reservoir, to begin for the acquisition of a considerable area of spill transformed in reservation, they show, now, that were valuable for the whole group;
- The forecasts of useful life for the reservoir were not confirmed in face of an adaptation that was done of a methodology developed for countries of Northern

Hemisphere, where the realities and natural conditions are very different from these in our country;

- The current situation of the basin, if it is not the desirable, it is not also too much preoccupying maintained the current patterns in to use and to occupy the space. However, it is of fundamental importance that COPASA implements more and more, not only in this spring, measured preservationists to seek to protect this fundamental raw material that it is the water.

Enclosed

Table 1: Use and occupation of the soil in the basin of Ribeirão Serra Azul-1983

Type of Covering	Area in km^2	Occupied total area (%)
Closed field	70,0	26,3
Savannah	48,4	18,2
Exposed soil	42,5	16,0
Agricultural areas	28,3	10,6
Field	24,1	9,1
kills dense	16,7	6,3
Reforestation	14,9	5,6
Cerradão	14,0	5,3
Forest grates	5,6	2,1
Urban areas	1,1	0,4
Small reservoir	0,3	0,1
Total	265,9 km^2	100 %

Table 2: Percentile granulométrico of the soils in the Basin of Ribeirão Serra Azul:

Sub-basin	**% M.O.**	**% Sand**	**% Sand dies**	**% Silte**	**% Clay**
II- Curralinho	3,4	6,63	35,84	26,9	30,52
III- Potreiro	1,9	13,8	35,05	26,9	21,30
IV- Estiva	2,3	24,7	35,9	27,0	12,40
V- Diogo	1,6	22,5	40,5	21,6	14,0
VI- S. Azul	3,2	17,2	34,1	24,9	23,7
VII- Jacu	1,7	21,7	37,2	23,0	18,6

Table 3: Given comparative área/perda of soils

Sub-basin	Area in **Há**	Steepness Average m/m	Medium loss **ton/ha**	Total of loss in tons	Loss in **Kg/m^2**
II- Curralinho	1.502	0,053	6,77	13.642	0,90
III- Potreiro	330	0,096	7,12	3.372	1,02

IV- Estiva	3.229	0,167	9,59	35.464	1,09
V- Diogo	3.298	0,173	11,43	26.130	0,79
VI- S. Azul	12.278	0,231	16,98	127.368	1,04
VII- Jacu	908	0,172	10,60	9.001	0,99

Table 4: Square comparative of produção/deliberação/deposição of sediments in Serra Azul/1983's bacia/reservatório

Sub-basin	Area in (km2)	Spiritual mediu m flow (m3/s)	Produced sediment (kg/m2)	Sediment Deliberate (%)	Deposited sediment (kg/m2)	Total produced sediment (tons)	Total deposited sediment (tons)
II	15,02	0,1165	0,90	24,70	1,60	13.642	992
III	3,30	0,0320	1,02	19,33	1,92	3.372	261
IV	32,29	0,3130	1,09	16,33	2,49	35.464	3.321
V	32,98	0,3270	0,79	16,16	1,71	26.130	2.329
VI	122,94	1,2760	1,04	19,49	2,27	127.368	11.516
VII	9,08	0,1120	0,99	19,86	1,82	9.001	694
Total	215,61	2,1765	5,83		2,15	214.997	19.113

Table 5: Evolution of the Use and Occupation of the Soil in the Basin of Ribeirão Serra Azul 83/94/2000

L. Gomide 1983			CETEC 1994		Dissertation 2000	
Covering type	**Área km²**	**Área total %**	**Área km²**	**Área total %**	**Área km²**	**Área total %**
Closed field	70,0	26,3	57,67	21,5		
Savannah	48,4	18,2			66,62	25,26
Exposed soil	42,5	16,0			2,03	0,77
Cultivated area	28,3	10,6			13,8	5,23
Field limpo/pasto	24,1	9,1	139,06	53,1		
Reforestation	14,9	5,6	4,34	1,6	2,79	1,05
Cerradão	14,0	5,3				
He/she kills dense	16,7	6,3	34,39	13,1		
Forest grates	5,6	2,1				
Urban area	1,1	0,4	14,6	5,6	3,09	1,71
Açude/represa	0,3	0,1	8,9	3,3	8,93	3,38
Forest natural/plant					16,83	6,4
Area of ranches					2,8	1,06
Divisions into lots desat.					2,21	0,83
Transition forest					2,15	0,81
Vegetation rupestre					1,85	0,70
Dirty pasture					27,99	10,25
Clean pasture					106,7	40,1
Mining			2,37	0,90	3,29	1,25
Other	0,0	0,0	2,37	0,9	2,62	1,2
Total	265,9	100	263,7	100,0	263,7	100,0

BIBLIOGRAPHICAL REFERENCE

- ANEEL, AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA: *Guia de Avaliação de Assoreamento de Reservatórios.* Newton Carvalho. Brasília. Dupligráfica Editora, 2000.140 p.
- ABRH, ASSOCIAÇÃO BRASILEIRA DE RECURSOS HÍDRICOS: *III Encontro de Engenharia de Sedimentos*. W. Geraldo & T. Fábio,Belo Horizonte, 1998. 363 p.
- ABRH, ASSOCIAÇÃO BRASILEIRA DE RECURSOS HÍDRICOS: *Assoreamento de Reservatório e Erosão a Jusante*. W. Geraldo & T. Fábio, Belo Horizonte, 1998. 363 p.
- CEMIG-COMPANHIA ENERGÉTICA DE MINAS GERAIS: *Guia Ilustrado de peixes da bacia do rio Grande. Belo Horizonte*: CEMIG/CETEC. 2000. 144p.:il, mapa.
- ENCONTRO BRASILEIRO DE ICTIOFAUNA: *Resumos* Campinas,SP. Pontifícia Universidade Católica de Campinas-ICB e Sociedade Brasileira de Ictiologia. 1983:.P2.
- ICOLD, INTERNATIONAL COMMISSION ON LARGE DAMS *Sediment control of reservoirs*. Committee on Sedimentation of Reservoirs. Paris. 1989.225p.
- LOWE-McCONNEL, R.H. Estudos Ecilógicos de Comunidades de Peixes Tropicais.Tradução Anna Emília Vazzoler, Ângelo Antônio Agostinho, Patrícia T.M. Cunnhingham- São Paulo: Editora Universidade de São Paulo, 1999.
- PROJETO MANUELZÂO (UFMG). Peixes do Rio das Velhas: passado e presente/ Carlos Bernardo Mascarenhas Alves, Paulo dos Santos Pompeu (organizadores). – Belo Horizonte: (S.N.), 2001(Belo Horizonte: SEGRAC). 192p: il.
- R.W. Duck. *Geomorphology and Sedimentology of Lakes and Reservoirs*.1993.John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex PO19 UD, England.

Photographic enclosure

Sediment deposited in lake

Mining Sediment

Collects of sediment

Exotic species

Hoplias lacerdae (they will Betray of Amazon)

Clarias gariepinus (African Catfish)

Cichla ocelaris (Tucunaré)

Native species

Salminus hilarii (Tabarana)

Leporinus macrophthalmus (piau-açu)

Prochilodus lineatus (Curimatã)