

DOCUMENT 25

**Evaluación ambiental de los sectores minero e industrial
SES y Secretaría de Medio Ambiente y Ministerio de Minería y
Metalurgia
Government of Sweden and the World Bank - 1993**

A. Authors

This survey was realized by SES in coordination with SENMA.

The team of SES was formed by experts and engineers in industrial water, mining processes, health and industrial security, solid wastes, industrial economy, environmental regulations. A lawyer specialized in environmental issues was also part of the team.

On the part of SENMA, the team was formed by a lawyer, specialists in geology, water resources, construction, waste management, health and industrial security.

B. Funding sources

Government of Sweden and the World Bank.

C. Objectives

The main objective is the establishment of the foundations of a strategy that would mitigate the environmental problems caused by the industrial and mining sectors, based on an assessment of those sectors on a national scale.

More specifically, in respect to the issue of the PRB pollution, the objectives are to:

- Identify and assess the impacts of the main industrial sources of water pollution, in environmental and social terms.
- Recommend actions in the short term that would improve the environmental situation.
- Offer new and concrete ideas referring to the promotion of the design of a legal and institutional framework appropriate to face pollution consequences.
- Propose amendments to the legal instruments related with the natural environment.
- Suggest criteria for the identification of mitigation projects that would require a special treatment.

D. Methodology

Globally, this work was realized respecting the following methodological steps:

- Information and data collection over the industrial and mining sectors and the environmental conditions.
- Meetings with representative of both sectors.
- Identification and selection of the cooperation sites to visit considering criteria of representation of the different sub-sectors, geographical covering, and enterprises of different sizes.
- Data collection through visits to the elected enterprises, visual observations and sampling of liquid effluents and solid wastes.
- Systematization of the information and data obtained through the visit.

- Meetings with public authorities and private companies, oriented to consultation and discussion over legal and technical aspects.

E. Results

With respect to the issue of the PRB pollution, the main products of this work are:

- Description of the political, legal and environmental context within which the mining sector is developing.
- Information about environmental issues related with mining production.
- Information about the mineral processing systems of different plants and mineral extracted by different mines situated within the PRB.
- Short assessment of the social impacts of mining activities (this means that it was not referring to the social impacts of pollution), in terms of cultural settings and traditional organization structures of the Andean region.
- Information and data on the pollution caused by mining in the areas of Potosí and Quechisla. Among the information and data presented, we should mention the following:
 - Annually, the Pilcomayo-La Ribera River transports some 1200 tons of zinc, 30 of arsenic, 5 of cadmium, 70 of copper, 11 of antimony and 200 of lead as dissolved elements. At the sametime, a larger quantity of solid elements is transported in suspension. Moreover, it is recognized that large quantities of sediments are accumulated in the river beds.
 - In the Quechisla area, characterized by an arid climate, some fifty, mostly small, operations exist. Regarding this area, it is indicated that the environmental impact is significant and that it is possible that land of the Vetillas sub-basin were contaminated.
- Identification and recommendation of the most urgent actions and programs oriented to the mitigation of environmental problems caused by mining activities
- Assessment of the potential costs of mitigation actions based on the construction of tailing dams.

This report offers a clear and concrete description of the socio-economic context related to the environmental issue prevailing in 1992. It takes into account important factors such as the organization of the state, and the economic and environmental policies. It also insists over the critical situation found around the city of Potosí.

The solutions proposed are based upon an integrated vision of the national and regional contexts. They offer interesting ideas on the way environmental impacts could be mitigated. Among them, the following should be mentioned:

- The mining sector has to pay more attention to the environmental issue
- In terms of regulations, new instruments should be designed with precaution but the limited effectiveness of those regulations should also be recognized.
- In terms of public policies and sustainable technologies, those latter should be promoted through economic incentive mechanisms and information diffusion.
- Strengthening of the capacity of laboratories and of human resources in charge of environmental monitoring.
- Assessment of the economic viability of the production systems of small enterprises.

- The report does not emphasize technical solutions, but the promotion of an adequate context for the improvement of efficiency and sustainability in the use of natural resources. It means that, at first, improvements of the political and legal context should be preferred over technical ones.
- In terms of institutional aspects, it is recommended to specify the institutional responsibilities related to environmental issues within the public sector and to strengthen the institutional capacity within and outside the government.

F. Global evaluation

Integrity of the focus

Considerations for the most fundamental aspects of the context and the professional diversity of the team described above demonstrate a clear willingness to apply an integrated approach to the analyzed issues. Even if technical solutions are given relatively low priority, the suggested solutions are also integrated.

Extent of the study

The study covers the country and all the sub-sectors of the mining and industrial sectors.

Quality and clarity of the methodology

The methodology is well explained and its application is successful.

Objective and scientific evaluation of pollution

The analytical results presented, as their corresponding interpretations, show a high level of objectivity.

Clarity and consistency of conclusions and recommendations

As it has already been indicated, recommendations and conclusions are clear, coherent and very interesting.

Quality of document presentation

The document is well structured and is easy to read. In the accessed version of the report, some small problems of pagination are observed

Historical references and their utility

A historical perspective allows to learn some instructive aspects on the evolution of the mining sector and to better understand the environmental problem associated with it.

Bibliographical references

Bibliography is complete and useful. It has been used to identify a large part of the documents considered in the present survey.

DOCUMENT 28

Review of the Porco mine tailings dam burst and associated mine waste problems, Pilcomayo Basin, Bolivia
University of Leeds and Marine Resource Assessment Group Ltd
Overseas Development Administration of the United Kingdom - 1996

A. Authors

This report was elaborated by Mark G Macklin, David Preston and Claire Sedgwick (University of Leeds - School of Geography) and by Ian Payne (Marine Resource Assessment Group Ltd).

B. Funding sources

Overseas Development Administration of the United Kingdom.

C. Objectives

The main objective of the report is 'to assess the extent of the environmental damage already done, the current risk and the likely future risks from seasonal changes in river flow rates' and 'to assess the effects on the fish population and possible consequent dangers to the human population'.

D. Methodology

No specific chapter is referring to the methodology applied. However, it is possible to observe that the report has been elaborated considering the following steps:

- Description of the background to the Porco incident.
- Visit to Porco mine and obtention of data and information through interviews and sample collections from sites situated in the Pilcomayo River Basin between Porco and Puerto Margarita.
- Interpretation of data and information.

E. Results

The main results are the following:

- Description of social and physical aspects of the Pilcomayo river basin (upper Pilcomayo and Pilaya sub-basins). For example, it is mentioned that the upper Pilcomayo sub-basin population is of 424.000 inhabitants (excluding the part of the population living in the Department of Tarija).
- Identification and evaluation of some impacts of the Pilcomayo river pollution. Amongst many valuable information, the following seems particularly important:
 - the degree of dependence on river water varies according to the site and the socio-economic situation of the people. The report states, for example, that many people living on its riversides have no alternative water source to the river and are unable to avoid drinking water at times of high silt load and possible maximum toxicity.

- the interpretation of the results corresponding to the water samples analyzed by the ODA mission stipulates that 'severe and widespread metal pollution has occurred in the Tumusla-Pilaya and Pilcomayo river basins arising from present and past mining activities.
- the extreme level of poverty and its associated low level of nutrition makes that many people are particularly vulnerable to water pollution, even with low levels of toxicity.
- the fishery for the sábalo of the Pilcomayo river is one of the largest suppliers of fish in the country with an average yield of 1.300 metric tons per year (Payne and Salas, 1993).
- the sábalo is an essential source of both food and income in the Guaraní region.
- some cultivated species (tomato) are more sensitive than others (potato, pumpkins, fruit trees).
- About the Porco incident, it is reported that the "black water" came in three waves, even by people living as far from Porco as Puerto Margarita. It is also said that people observe no particular mortality in fish or other animals associated with those waves. However, the report states that amongst the main risks with this kind of pollution are the bio-accumulation of heavy metals and the asphyxia of fishes caused by an excessive sediment load in the water. It is also said that the incident of Porco has demonstrated that wastes from the mining area in the headwaters of the basin does reach the lower parts of the river.
- Identification of some locally designed alternatives for partial decontamination, such as the use of the leaves of a local plant (in the Guaraní area) to speed the settlement of silt.
- In a report of a study conducted between June and August 1996 by QPID and CER-DET, it is mentioned that fishes were encountered with significant amounts of arsenic, copper, mercury, lead, tin and zinc.

The main recommendations are:

- The realization of an immediate assessment of the magnitude of the continuous discharge from small-scale mining and of the stability of large storage structures.
- The assessment of the risk associated with the regular consumption of fish and of river water caused by chronic mine waste pollution. Monitoring should include sediment, water, fish and socio-economic indicators.
- The provision of simple tube-wells for communities living on the riversides and that need to drink the river water.
- The improvement of the Pilcomayo river basin management through co-ordination at an international level and with the support of the international community and funding agencies.

F. Global evaluation

Integrity of the focus

Among the reports considered, this is probably one of the best in terms of the integrity of its approach.

Extent of the survey

The survey considers the Pilcomayo river basin from Porco (Department of Potosí) to Puerto Margarita (Department of Tarija).

Quality and clarity of the methodology

The methodology is considered to be efficient, having met the objective of the survey in a very short period of time.

Historical references and their utility

Although some references are mentioned, these are mostly limited to generalities.

Bibliographical references

Only two references are presented in annex.

Other comments

It is useful to contrast the observations made by this mission with the reports published by the COMSUR Company and by the Ministry of Sustainable Development and Environment (MDSMA).

The report of the latter indicates that 'as a result of the opportune intervention and actions realized by the national and departmental authorities, by COMSUR and by the peasant communities, it has been possible to control and mitigate the negative effects that could have been caused by the Porco Mine dam burst'.

Meanwhile, the ODA report indicates that 'the length of the Tumusla-Pilaya system affected by the Porco mine spill was considerably greater than suggested by MDSMA'.

Comparing both reports shows how serious is the problem of information management when treating the Pilcomayo's pollution issue.

The present report, particularly in terms of the information referring to the fisheries, has benefited from the reports of past missions organized by the ODA Misión Británica in collaboration with the Centro de Desarrollo de la Pesquería (Bailey 1973, Payne 1986, Payne and Fallows 1987, Payne and Harvey 1989 and Payne and Salas 1993).

This survey is the only one that mentions something on the following fact: the mine waste disposal problem in the headwaters of the river constitutes a time bomb threatening any future development of water resources within the river basin.

V. CONCLUSIONS ABOUT THE EXISTING DOCUMENTATION

From the analysis of the processed information, it is possible to give an outlook of the environmental and socio-economic problems caused by the mining sector in the Pilcomayo River Basin (PRB).

First of all, a map has been elaborated referring to the main pollution sources from the mining sector and the pollution levels of the main rivers of the six sub-basins forming the PRB in Bolivia. This map includes the information found in documents 3, 6, 8, 11, 13, 15, 16, 17, 18, 21, 24, 25, 28, 29 and 30.

The approximate geographical position of the pollution sources (mines and processing plants) is based on the information presented in document 6.

Document 19 constitutes the main source of information referring to the geographical situation of the rivers and sub-basin limits presented in this map.

It would have been possible to present on the map the specific source of the information but it has seemed to be more appropriate to detail this information on a specific chart because of the existence of some contradictions between documents.

Table 1.

Pollution levels of rivers pertaining to the PRB according to different information sources (part of the documents commented in the present report).

River name	Low Pollution Level	Medium Pollution Level	Heavy Pollution Level
Upper Pilcomayo			8, 24
La Ribera-Pilcomayo			6, 15, 23, 25, 28
La Lava			6, 11, 13, 21, 23, 25
Toropalca – Tumusla	29, 30	6, 13, 25	11, 28
Cotagaita		6, 17	15, 16
San Juan del Oro	17	6	15, 16
Pilaya	6, 30	3	24, 28
Vitichi		6	
Caiti		6	
Qhechisla		6	
Tupiza		6	
Tatasi		6	
Viluyo		6	
Blanco		6	
Tazna		6	

The figures in the table relate to the document numbers referred to throughout the present report.

In case of contradictory assessments over the pollution levels, as can be observed in Table 1, the rivers have been coloured mixing red and green. This occurs for the Cotagaita San Juan del Oro and Toropalca-Tumusla river basins.

The map also reports about the lack of information on the PRB's pollution levels in its lower part (questions marks on the map). But some information is available for the river downstream from Malmisa mine (this information comes from one of the Malmisa mine owners).

Documents such as number 1, 5 and 22 also contain data and information related to pollution levels of certain rivers. However, they have not been used for the elaboration of this map, for reasons that are exposed in the respective comments.

Concerning the graphical report of the impacts identified and/or assessed by some investigators, this has been considered as an impossible task. There are two basic reasons for this situation:

Firstly, the documents referring to pollution impacts (apart from the simple observation of increased concentrations of heavy metals in water draining mining operations), such as documents 1, 5, 6, 8, 10 and 22, suffer from serious deficiencies in terms of objectivity and/or scientific bases.

Secondly, it is considered that the lack of information system for monitoring the social, environmental and economic situations of villages supposedly affected by pollution, makes it difficult to assess the impacts of identified pollution causes in an objective and scientific mode. This does not mean that there are no impacts. But their analysis is not consistent so far ¹.

Apart from the information presented on this map and in general terms, it clearly appears from the analyzed documentation that:

- There are substantial differences between the levels of knowledge over the sub-basins forming the PRB. Effectively, the dynamics and state of some sub-basins in socio-economic, as well as in environmental terms, are still insufficiently understood or known (Lower Pilcomayo, Mataca, Malmisa, Pilaya), while some other sub-basins have been regularly surveyed (La Ribera-Pilcomayo and La Lava).
- Part of the available information and data suffers from deficiencies caused by different factors. The most common ones are:
 - Lack of a global framework of analysis and difficulty for the investigators to integrate different social, environmental and economic parameters and to take into account the relationships between these parameters (what is called an integrated approach).
 - Lack of consistent methodologies of investigation or insufficient information given about the methodology applied (see documents 5 and 22).
 - Spatial and/or temporal limitations of the surveys.

- Subjectivity of the collectors and/or of the interpreters of the data and information (compare documents 29/30 and 11/28).
 - Limitations of the investigation team in terms of financial and/or professional capacity.
- Two main characteristics are reinforcing each other and are making it difficult to improve the global understanding of the problem:
 - The contexts in which pollution occurs, as well as its causes and impacts, are everything except static and homogeneous. They change over time and over space.
 - The information related to the pollution of the PRB has mostly been obtained during the last two decades, while the present pollution caused by mining activities is rooted five centuries ago.
- Some parameters, highly relevant to the assessment of the causes and impacts of pollution, are not or inadequately monitored (climate, soils, river flows, subterranean water resources, social practices, nutrition, human health, production costs and benefits in agriculture and mining sectors, etc.).
 - The level of reliance of the information varies and must be assessed before the effective use of this information. ² However, the combination of the enclosed map with the chart above allows for an easy comparison and analysis of all the key data and information about any given part of the basin.

Based on this general assessment, the most relevant aspects about the context and impacts of the PRB pollution as well as the most attractive solutions are presented below.

V. 1. Existing information about the regional context

Generally the existing information is scarce and refers to small areas studied during short periods of time. Furthermore, those surveys are mainly selective and pay insufficient attention to the relationships between all the elements to be considered.

However, the following aspects are considered as particularly relevant:

Environmental context

- The pollution levels in terms of heavy metal concentrations observed between the Pilaya River and Villamontes, following document 2 and 3, are low or nil. This is questioned in document 28.
- Documents 6 and 13 report some analytical results concerning soils situated downstream from mining operations and indicate that the land is partially polluted by elements such as cadmium (Cd), zinc (Zn), lead (Pb) and boro (B).
- There is a clear consensus about the fact that almost all the rivers draining operating mining areas are chemically contaminated. Effectively, all documents are reporting excessive pollutant concentration close to the mining operation centres. Discussion can appear when the pollution levels are assessed at some distance from the pollution sources.

- Very few mining companies have adopted technologies or treatment systems oriented to mitigate their impacts on the environment (documents 25, 29 and 30). The large majority of mining operations are realized without any or with insufficient treatment of their liquid and solid wastes (documents 12 and 28).
- An interesting case is reported by document 13; it refers to the fact that indigenous people have expressed that pollution occurs through short events and is not permanent (Toropalca sub-basin).
- PHICAB in document 19 mentions deficiencies with respect to meteorological data collection and the lack of information about sub-basin limits.

Economic context

- The main pollution sources from the mining sector are quite well identified, in terms of operations which have ceased some few years ago or that are still active. In this respect, documents 6, 13, 15 and 25 add a lot of useful information. They report the principal characteristics of those operations (kind of technology, volume and type of mineral treated, geographical position, etc...).
- Very little or no information at all has been found in most documents about the pollution potential of abandoned sites and of sediments deposited in riverbeds. These aspects can however not be lost of sight in any operational approach in the future.

Social context

- Amongst the social aspects related to the pollution of the PRB, human health occupies a particularly important place. Its monitoring in Bolivian departments such as Potosí is generally irregular and faces insufficient human, technical and financial resources compared with the magnitude and extension of the problems.
- Principally referring to the Pilaya–Pilcomayo sub-basin, document 28 constitutes one of the very few documents offering interesting information and data confirming the variability of social contexts (degree of dependency on river water). It also reports about the extreme level of poverty and low level of nutrition which make people more sensitive to pollution effects. Furthermore, it informs about the socio-economic significance of the silver fish fishery (sábalo).

Legal and political context

- Bolivia has made substantial efforts approving legal instruments designed to conserve its environmental assets. However, three main problems are now faced:
 - Resources are lacking for the effective application of those instruments and there is no perspective concerning the national capacity to obtain sufficient financial resources so as to support the corresponding costs.
 - There are strong social and economic interests opposed to most of these regulations.

- The application of the new norms is causing and will cause a series of social and economic negative impacts. This is mainly due to the fact that a large part of national companies are already suffering from difficult economic conditions, caused by many factors such as high costs of electricity and transport. Those norms and regulations are progressively imposing the internalization of the environmental costs of production. The situation is obviously even worse for the poorest sectors of the population that will have to adapt themselves to those legal mechanisms.
- Document 25 offers some information about those contexts, confirming that substantial improvements could be made. Following this approach, it is particularly clear that the context created by economic policy and legal instruments should be considered in any analysis of this issue.

In general terms, as suggested by SES, the effectiveness of legal instruments is limited and the legal instruments should probably be designed with much more precaution, considering their social and economic impacts, as well as the costs of their application.

Normally, political measures such as particular fiscal, credit or pricing conditions have more possibility to be accepted and well received by the population because they are attractive economically and they concern both agriculture and mining sectors. This kind of policies should be considered to encourage the sustainable management of natural resources and compensate efforts made towards the internalization of environmental costs of production.

V. 2. Existing information about the pollution impacts caused by mining activities

Environmental impacts

It is clear that the main difficulty to assess environmental impacts in the PRB is the lack of information about the state of the ecosystems and about the corresponding ecological processes.

For example, is it very difficult to assess objectively the environmental and socio-economic impacts of a tailing dam burst, without having a clear knowledge of the situation prevailing before the event.

This is the reason why it is definitely necessary to establish a monitoring system in order to collect some reliable information about pollution levels in soils, water resources, sediments, etc.

The analysis of the documentation has largely confirmed this situation:

- Most information and data, commonly presented as part of the impact assessment, are only elements of diagnostics. In this sense, if such information and data are demonstrated to be reliable, it could eventually become a starting point for the implementation of monitoring systems.

- Some surveys, such as that reported in document 2, emphasize the difficulty of assessing pollution impacts. Another common difficulty is the lack of specificity of most symptoms which makes it difficult to determinate the incidence or responsibility attributable to different potential causes.
- Almost all impact assessments realized until now are very punctual in time and space and are made without sufficient references about the situation prevailing before the occurrence of the fact which is supposed to be the cause of these impacts.
- Ultimately, supposing that adequate parameters could be identified to assess the pollution impacts, there would still be the difficulty of determining if the effects observed are the products resulting from the present or past emissions.

Social and economic impacts

If environmental impacts can not be assessed, how could we evaluate the social and economic impacts of pollution? It is obviously more difficult because these parameters are influenced by a large series of factors. For example:

- Emigration of rural people towards cities and other rural areas is the product of factors such as agroecosystems potentials, market prices of their traditional products, climatic conditions, state and private sector interventions (including development projects), economic policy, etc...
- Health conditions are also influenced by many different factors: water pollution by biological elements, consumption of alcohol and/or tobacco, inadequate food regime, excessive work intensity, lack of sleep, etc.

Almost all documents address, in some way, the issue of the socio-economic impacts of pollution and this topic is central for documents 1 to 5, 8, 10, 22, 29 and 30.

However, reliable data and information are scarce, particularly concerning parameters such as land, crop and animal productivity, emigration, disease in humans, animals and plants. This situation has very serious consequences because it dramatically restrains the possibilities to identify solutions that correspond to the real needs of the region.

Based on regional experience it is considered that the inappropriate management of water and tailings by the mining sector, through its present and past activities during centuries, and the emission of millions of tons of wastes as toxic as cadmium, lead, arsenic and mercury, which are now spread across the PRB, constitute a very harmful and insidious cause of the present socio-economic regional crisis.

At the same time, unsustainable management of prairies and soils by the rural population are at the root of generalised soil erosion and river sedimentation processes.

These processes act in a complementary way with water and soil pollution, leading to dramatic social and economic consequences in the whole PRB. This aspect is certainly underestimated and almost inexistent in the documentation assessed.

Even in the absence of precise data, the regional experience allows for listing the main following consequences of these two factors (mining and soil erosion):

- Loss of land productivity and misery originated by the destruction and/or the pollution of the best land (alluvial areas) through inundation intensified by the brimming of river beds, and/or by the deposition of particles potentially harmful for plants and/or soil conditions.
- Loss of opportunities in terms of creating irrigation systems and hydroelectric dams caused by sedimentation and/or pollution.
- Increased pressure over marginal land, caused by the loss of alluvial plains.
- Disappearance of the cheaper source of natural protein (fish) in areas situated close to mining operations.
- Profound disturbance of the traditional Andean social organization.
- Chronic malnutrition and serious worsening of health conditions.
- Lack of employment opportunities and progressive emigration.
- Rapid destruction of infrastructure such as road and dams caused by sedimentation and inundation.
- Social conflicts.

V. 3. Existing information about the possible solutions

As it has been observed, there is a tendency in the available documents to favour technical solutions over political and legal ones.

Technical solutions

- Some technical solutions coincide with the impacts identified. This is the case with documents 6 and 8 which propose the realization of land rehabilitation programs. But this technical solution is made without previous assessment of other potential causes of land degradation, such as inadequate land use or inappropriate practices causing soil erosion, are considered. Another question referring to this proposal is that no idea is given about the costs and potential economic benefits associated with it.
- Interesting proposals, made in document 13, suggest that abandoned mines should be treated in such a manner that water would not be allowed to enter them. This proposal is obviously justified in technical terms. The question would be to determine who would be charged with the costs of such measures.
The author also suggests the promotion of the use of less toxic chemicals.
- The monitoring of water and agricultural products and river flows, interests many institutions, villagers and experts (6, 8, 13, 15 and 25).

- The construction or improvement of irrigation systems capturing and transporting good quality water (8 and 13), the monitoring of local people's health (8), the construction of tailing dams (15 and 23), the implementation of more efficient systems of production, which would release less wastes transforming them into benefits (15 and 25), the improvement of regional laboratories (13 and 25) and efforts oriented to the improvement of monitoring centres which would collect data about rain and river flows (19) are also suggested.

Political and legal solutions

The recommendations presented in document 25 are interesting and should be developed. They include the precautionary design and application of legal instruments accompanied by governmental policies oriented to the creation of economic incentive mechanisms favouring the adoption of sustainable technologies. It is suggested that important economic factors, such as water, energy and waste disposal prices, should be used to promote an efficient management of natural resources.

- 1 Present on a map impacts such as a 41 % diminution of gross benefits for "campesinos" in Chuquisaca, without specifying the years of production considered, the type and prices of products sold, the value of the national money and the climate having characterized the years of production considered, only would serve to create confusion.
- 2 A simple example can confirm the limited information and data confidence, even at the macro-level: PHICAB in document 19 states that the total area corresponding to the PRB in Bolivia is of 92.971 km². However, the EC-Request 4234-1995, mentioned by FOBOMADE in document 24, informs that this area would be of 80000 km². Finally, following QPID, FIA and CER-DET in document 4, the PRB area in Bolivia is supposed to cover 98.000 square kilometres.

VI. RECOMMENDATIONS

Based on the assessment above and on its conclusions, some recommendations are now presented. They intend to give concrete suggestions that could improve the understanding of the issues related to the PRB pollution problems, and to alleviate the critical situation faced by its inhabitants.

These propositions are mainly based on the knowledge obtained through the realisation and assessment of rural development projects in the region. This methodological approach consists for instance in integrating socio-economic factors in the environmental strategy, in order to improve its impact and its feasibility.

The three main fields of intervention recommended to that aim, are:

- Monitoring the Pilcomayo River Basin
- Implementing projects that address the very causes of the socio-economic problems resulting from the pollution produced by the mining sector;
- Creating a favourable context for the projects and activities that address the causes of pollution .

The proposed approach to these initiatives consists in:

- integrating some socio-economic factors in the preparation, implementation in monitoring of any study or physical investment in the sector. By doing so, it will be possible to better identify the priority needs, to optimise the impact of the projects and to enhance the sensitisation and motivation of all parties concerned;
- developing a participatory approach: an optimal participation of the different social and economic sectors and institutions concerned, will strongly improve the feasibility of any proposed action. This suggestion comes from the too frequent observation of the serious problems faced by interventions characterised by authoritative intervention and insufficient participation of local actors in planning, as well as in executing and monitoring development projects;
- integrating the recent institutional development of Bolivia into any proposed action; the “Ley de Participación Popular” provides some good opportunities for involving (and funding) local communities in some field action. The “municipio” and the “OTB” (Organización Territorial de Base) for instance, will be key players in the sector in the future;
- strengthening the process through quick-impact actions; whatever action is undertaken, be it at study or institutional level, this action should also pay attention to the identification and rapid implementation of some small field actions that will be of direct social and/or economic interest for the local population and for the local stakeholders;

VI.1. General methodological recommendations for any future project in the sector:

Any action in the sector could/should adopt some of the following modalities:

- Co-ordinated action between public and private institutions oriented to the organisation of the monitoring system implementation process.
- Evaluation of the resources available at the local (‘municipios’), regional (department), national and international levels;
- Creation of a legally recognised instance which would be responsible for the monitoring of the project;
- Identification and selection of institutions able and motivated to assume the corresponding activities.

VI.2. Monitoring the Pilcomayo River Basin

The previous investigations could have paid more attention to the socio-economic crisis prevailing in the PRB area, because poverty is closely related with the environmental degradation process that is now affecting the most significant resource of the area: water. The uppermost importance of this resource in terms of social and economic development potential of the region indeed requires such particular attention.

Regrettably, the assessment of the available information demonstrates that those socio-economic aspects have only been treated superficially so far, and without the required human and financial resources.

However, it also shows that this issue must be considered as of the highest importance by people and institutions interested in improving the situation faced.

Any future project for monitoring the contamination of the Pilcomayo basin should therefore include:

- the incorporation of socio-economic criteria in the selection of areas to monitor: demography, migration, agriculture, social and economic structure of the mining business, economic potential of the area...;
- the design of an integrated monitoring methodology, that would register not only the physical impact of the contamination but also its social and economic impacts;
- the elaboration of an action plan covering at least a five-year period in order to assess the variation of the pollution over time but also the effect of the pollution on human settlement and activities;
- the monitoring and evaluation of the action, according to a protocol established beforehand, and associating all parties concerned including the population itself;
- sufficient guarantees in terms of financial support and personal stability. The role of the international co-operation agencies will be of crucial importance.
- sufficient independence from the established economic and political interests, that may have sometimes influenced the objectivity of such initiatives in the past. In this sense the institution in charge of the monitoring of the project should be financially and politically independent.
- the regular assessment of the capacities and performance of the participating laboratories;
- mechanisms allowing for the participation of local people and industries. Local people represented by their local authorities should be constantly informed of the information and data obtained, as well as of the corresponding interpretations. Even more, they should participate during the collection of data and be progressively prepared to collect it by themselves
- mechanisms to guarantee the progressive training and specialisation of the personal of the involved institution;
- a side-budget for the immediate implementation of any simple and effective physical action that would be assessed as potentially being of direct benefit for the local population .

VI.3. Implementing projects that address the very causes of the socio-economic problems resulting from the pollution produced by the mining sector

Any field project in the sector should also adopt some of the following modalities:

- inclusion of socio-economic factors in the objectives, activities, outputs and indicators of the project;
- invitation to the mining and other public and private interested sectors, presentation of the project, discussion and consensus over the strategic lines to be implemented.
- inclusion of socio-economic parameters in the selection of the mining operations to be improved - see above;
- a detailed assessment of the production systems of the selected operations;
- the inclusion of socio-economic criteria in the selection of the technical solutions adopted;

- the investigation at the national and international levels oriented to the selection of the most adapted and efficient technical solutions (document 21).
- the socio-economic evaluation of the costs and potential benefits of the selected solutions;
- the elaboration of a detailed, integrated strategy of action. This should be done in co-ordination with all sectors and in function of the available resources, the motivation levels of different actors (miners, municipios, villagers, etc...), as well as of the economic, political and social context of the moment.
- the consideration of the need for securing the sustainability of tailing dams and sites where solid wastes are accumulated over very large periods of time. The costs of maintaining the closed sites should be evaluated and incorporated in the costs of operation, long before the closure of the processing plant. Also long before the operation closes, the financial resources and the action plan required to maintain those sites in optimal conditions until risks disappear should be presented and approved by public and private representatives.
- a financial participation of the mining companies. No such projects should be fully subsidised. However, taking into account the economic problems of the country in general and of the mining sector in particular, such participation should not be imposed before having established a legal and institutional context in which miners would be encouraged to act in a sustainable way (see below).
- the installation of a monitoring system through all stages of the project.

VI.4. Developing structural measures to create a favourable context for the projects and activities addressing the causes of pollution

Such initiatives are mentioned here for the record mainly; however it may be useful to underline such needs during the implementation of any study or project. When considering structural solutions to environmental problems, it is generally referring to legal and political measures. As said earlier, it would be more advisable to focus on political initiatives.

To reach the goal of creating a differentiated context for those producers assuming measures to protect water and/or soils and for those who do not, the following methodological steps can be recommended:

- Organising workshops with the participation of representatives of all interested economic sectors and of the Ministry of Sustainable Development and Planning, with the objective to better identify the environmentally harmful national policies and practices; and assessing their environmental impact;
- Elaboration of propositions for reforming these harmful policies;
- Discussions and efforts towards consensus upon the proposed reforms;
- Co-ordination and negotiation of the propositions with policy makers, aiming at the application of the proposed reforms;

More generally and at an international level, in the global economy prevailing now, structural incentives could be designed through a better co-ordination between countries interested in promoting environmentally sustainable mining activities. Efforts could also be made towards the planning and organisation, at the international level, of commercial

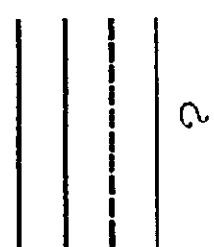
systems aiming at the generation of economic benefits from the adoption of environmentally sound production systems. This would be a reproduction of what has for instance already been realised in the timber market for the wood produced in forests that are managed in a sustainable way. This obviously falls outside the scope of this study.

VI.5. Follow-up of additional information and studies

Considering the issues treated by documents 33, 34, 37, 38, 39 and 40 and by the institutions that have funded their elaboration, it is highly recommended to proceed to the analysis of these documents. Furthermore, document 41 is also part of the recommended lectures, even if the European Community Commission probably owns much more information referring to the PRB than this single survey.

REFERENCES

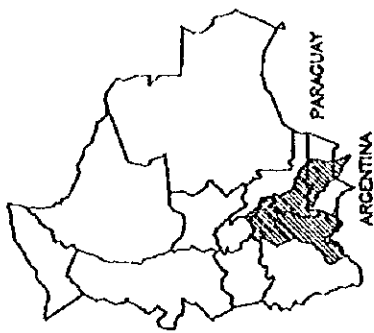
POLLUTION LEVEL



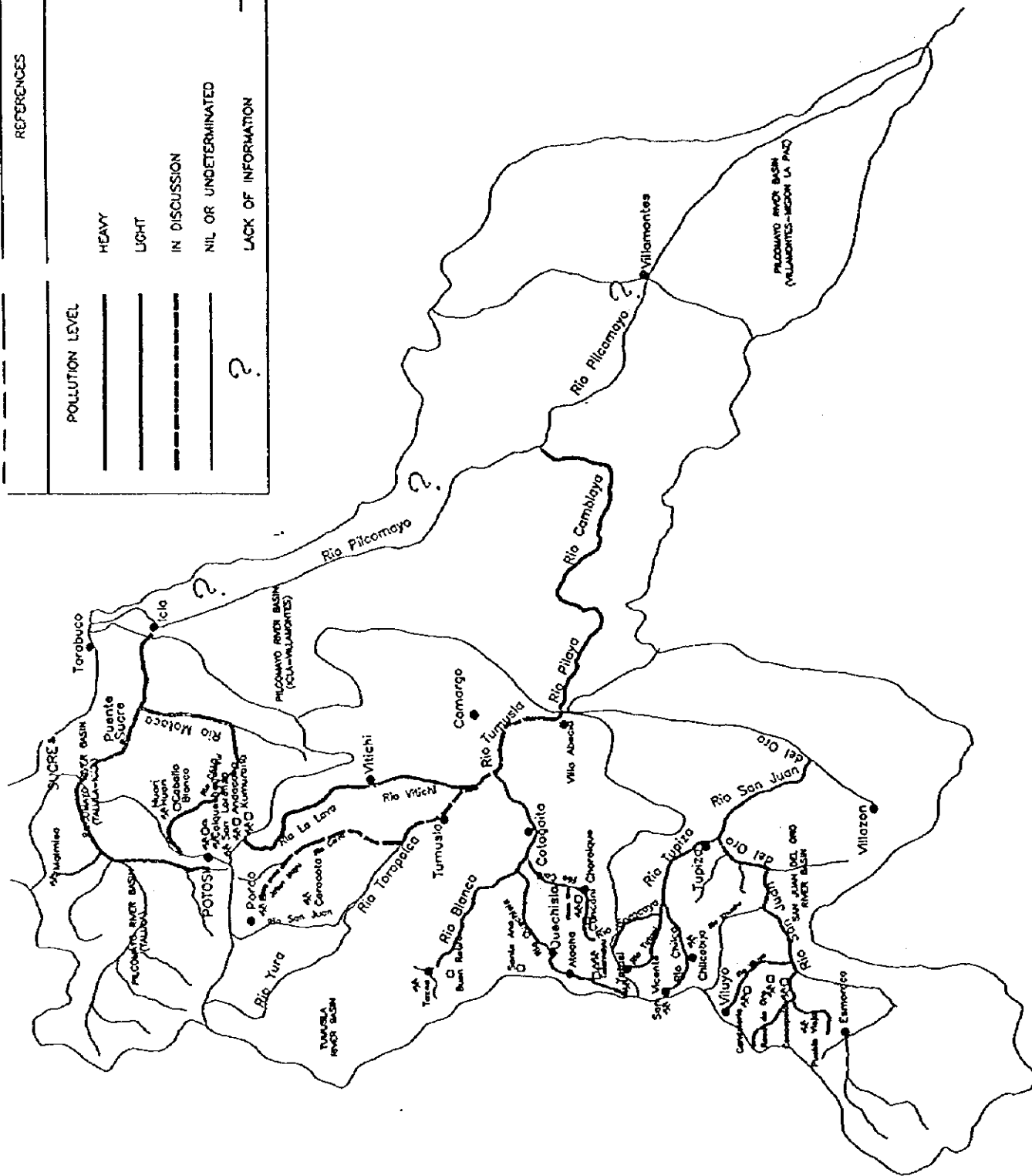
- ☉ MINE
- TREATMENT PLANT
- △ MELTING PLANT
- LIXIVIATION PLANT
- TOWN
- RIVER BASIN LIMITS

- HEAVY
- LIGHT
- IN DISCUSSION
- NIL OR UNDETERMINATED
- LACK OF INFORMATION

REPUBLICA DE BOLIVIA



0 80km



ANNEXES

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ANNEX 1:
TERMS OF REFERENCE

ANNEX 1: TERMS OF REFERENCE

Propuesta de Términos de referencia para una misión de apoyo a UNICO en el marco de su trabajo sobre la problemática de contaminación provocada por las actividades mineras en Potosí - Bolivia.

Referencia :

“ Estudio de condiciones de contaminación debida a la actividad minera (daños a la agricultura, ganaderia y pesca) ”

Objetivo del trabajo :

Síntesis de la información existente sobre el impacto socio-económico de la contaminación minera del rio Pilcomayo.

Antecedentes :

La contaminación física y química del rio Pilcomayo cubre un extenso territorio de Bolivia (parcialmente tres departamentos) y de los países vecinos. Por este motivo, el problema ha sido estudiado por numerosas instituciones bolivianas, paraguayas, argentinas e internacionales.

La información disponible demuestra claramente que los impactos de esta contaminación son y serán catastróficos para las personas y territorios afectados.

Cotidianamente y desde siglos, los ingenios y las cooperativas mineras botan productos químicos de alta toxicidad a los rios de la región lo que ha creado un pasivo medioambiental muy importante.

Los impactos conocidos son principalmente de tipo social (salud, actividades tradicionales), económico (agricultura y fruticultura, pesca, ganaderia) y ecológico (contaminación de los suelos, de los recursos hídricos, etc.)

Las grandes cantidades de desechos tóxicos depositados en el lecho de numerosos rios, en los embalses naturales y artificiales y sobre los terrenos agrícolas provocan una contaminación crónica, difícil de diferenciar de los impactos inmediatos ligados a los residuos actuales.

Los estudios efectuados hasta el momento se interesaron prioritariamente a los impactos medioambientales. Sin embargo, existen varios informes relacionados a los impactos observados en la salud y las actividades tradicionales. Son estos documentos que se analizarán prioritariamente durante esta misión.

Está claro que un análisis serio de los datos e informaciones obtenidos durante los últimos 20 años permitirán, por una parte, hacerse una idea clara y precisa de la intensidad del problema y, por otra, presentar recomendaciones sobre la oportunidad de futuras intervenciones.

Metodología propuesta:

1. Búsqueda y adquisición y/o reproducción de los datos (en las Prefecturas, Lidema, Cooperación internacional, ...), publicaciones y materiales disponibles relacionados con:
 - las fuentes de contaminación (ubicación geográfica y principales características técnicas)
 - el tipo y la intensidad de la contaminación según las fuentes identificadas
 - los resultados analíticos obtenidos en laboratorios e instituciones confiables
 - las regiones afectadas, su extensión y principales características sociales, económicas y ecológicas
 - los diferentes tipos y niveles de impactos socio-económicos observados durante los últimos 20 años
 - las principales tendencias observadas en términos de mejoramiento, estabilización o empeoramiento de la situación, según las cuencas consideradas
 - las eventuales medidas de mitigación implementadas y su impacto
2. Definición de los criterios de selección y análisis de la información obtenida.
3. Análisis del valor y consistencia de los documentos en términos de metodología y contenido.
4. Elaboración de un informe de síntesis con el contenido siguiente:
 - El estado actual de los conocimientos relacionados a los impactos socio-económicos de la contaminación del río Pilcomayo.
 - Una lista de recomendaciones concretas destinadas a establecer una escala de prioridades para futuras intervenciones en función de la intensidad de los problemas de contaminación identificados.
 - Una lista de medios humanos, institucionales y técnicos disponibles localmente para una participación en estas acciones futuras.
 - Los medios a implementar para profundizar la comprensión de la problemática.
 - Los tipos de acción mejor adaptados al contexto político y socio-económico local y cuyas relaciones costo/beneficio parezcan ser las más atractivos.

ANNEX 2 :
GENERAL BIBLIOGRAPHY

ANNEX 2: GENERAL BIBLIOGRAPHY

A. Evaluation of mining pollution in Bolivia or of the Pilcomayo River Basin

1. **Contaminación ambiental en los Cintis**
Murillo, J.-C. Bazán y O. Vera.
FOCHMADE y Universidad de San Francisco Xavier de Chuquisaca - 1997
2. **Rio Pilcomayo**
 - * Studies about the lead concentration and other toxic metals in muscles, inner organs, bones, and entire bodies of the silver fish (*Prochilodus platensis*)
 - * Studies about the concentration of lead and Zinc Protoporphyrine in the Guaranian's blood.
 - * Determination of lead in the silver fish, entire fish, and different parts, and blood tests of the Guaranians of the Itika Guasu area.

Russel Groves, Melanie Quevillon y Roxana Castro
CER-DET y QPID - 1997
3. **Rio Pilcomayo: Estudio sobre la concentración de plomo en sangre humana y las diferentes partes del sábalo**
Russel Groves, Melanie Quevillon, Roxana Castro y Delfina Morales de Arnéz
FOBOMADE, F.I.A. y Prefectura del Departamento de Tarija - 1997
4. **El Río Pilcomayo: una evaluación de la contaminación de metales en el pez Sábalo, un alimento básico para los Guaraníes del Itika Guasu**
Melanie Quevillon, Christina Gibb y Jonathan Dogterom
QPID, CER-DET y F.I.A. - 1997
5. **Informe sobre los daños causados a los agricultores por la contaminación del Río Pilcomayo - 1997**
e Informe técnico mensual de consultoría Cuenca Pilcomayo - 1996
Ing. Epifanio Pacheco C.
Prefectura del Departamento de Chuquisaca
6. **Evaluación del grado de contaminación en aguas y suelos de las principales cuencas menores del Departamento de Potosí**
U.A.T.F.
FONAMA - 1996
7. **Memoria del Ier encuentro internacional sobre el Río Pilcomayo**
CER-DET – FOBOMADE – F.I.A. - 1996

8. **Análisis del impacto socio-económico de la contaminación del río de La Ribera-Pilcomayo**
Lic. Jaime Hinojoza D. y Lic. Samuel Rosales R.
MEDMIN - 1995
9. **Problemática integral del Río Pilcomayo**
FOBOMADE y CER-DET - 1994
10. **Muestreo, análisis y evaluación de muestras de sangre de pobladores de la zona de La Lava, P. Linares, Potosí.**
PIHQ Oruro
PACC Potosí - 1994
11. **La minería y el medio ambiente - Estudios ambientales en las regiones de Toropalca y Andacaba-Cumurana-La Lava (Departamento de Potosí)**
Lothar Hahn
Proyecto de Cooperación Geológica Boliviano-Alemán - 1993
12. **Impact of the minerals industry on the environment in some areas of the departments of Oruro and Potosí: a preliminary study of stream waters and sediments**
Noras, Solis and Torrico
Ministerio de Minería y Metalurgia: Proyecto de Rehabilitación del Sector Minero - 1992
13. **Informe de misión sobre la contaminación de aguas por la explotación minera en las regiones de Uncía y Otavi – Departamento de Potosí, Bolivia**
PAC
Comisión de las Comunidades Europeas - 1991
14. **Primera Mesa Redonda sobre “Contaminación de Aguas en Bolivia”**
1983

Three articles:
 - “Contaminación originada por la industria minera” of Narciso Cardozo R.
 - “Contaminación de la industria minera” of Mario Sahonero I.
 - “Legislación” of Waldo Vargas B.
15. **Impacto ambiental de la actividad minera de Comibol en Bolivia**
Duran de la Fuente H. y Sergio Castro F.
Banco Mundial - 1989
16. **An environmental overview of the mining sector in Bolivia**
Nolan, Davis and Associates Limited
Report to the World Bank - 1988

17. Efectos, Alcances y magnitud de la contaminación de aguas dentro el área de influencia del Proyecto San Juan del Oro
Nilda Fernicola
PNUD – Proyecto BOL/80/001 - 1983

18. El Río Pilcomayo – Las características de la Cuenca y la calidad del agua dentro de la Zona propuesta de inundación de la represa Caipipendi en la Zona Guaraní, Itika Guasu
Tony Brown, Stephen Keith y Anna Wilkinson
QPID – CER-DET - FOBOMADE - 1995

B. Pilcomayo river basin or sub-basins diagnosis

19. Balance hídrico superficial de la Cuenca del Pilcomayo
Ricardo Arellano Albornóz
PHICAB - 1988

20. Cuenca de La Plata – Aprovechamiento múltiple de la cuenca del Río Pilcomayo
OEA
Governments of Bolivia, Argentina and Paraguay OEA – PNUD - 1977

C. Propositions of solutions and projects

21. Sistema de tratamiento pasivo del agua de riego para la comunidad de La Lava – Fase I
Ricky Collins
MEDMIN – PAC/C - 1996

22. Manejo Equilibrado y Sostenido de la Cuenca del Pilcomayo (perfil de proyecto)
Lic. Wolfgang Maier e Ing. Epifanio Pacheco C.
FOPROPE - 1996

23. Estudio de factibilidad para la construcción de un dique de colas en Potosí – Bolivia
Golder Associates Ltd.
MEDMIN - 1996

24. Problemas del Río Pilcomayo: soluciones planteadas
Ing. Ivan Medina H.
FOBOMADE - 1996

25. Evaluación ambiental de los sectores minero e industrial
SGAB y Secretaría de Medio Ambiente y Ministerio de Minería y Metalurgia
Gobierno de Suecia y Banco Mundial - 1993

26. Minería y gestión ambiental en Bolivia
Javier Salinas R.
Secretaría Nacional del Medio Ambiente - 1993

27. Proyecto Kumurana: estudio para el tratamiento de aguas de mina y efluentes del ingenio
I.I.M.M.
Empresa Kumurana - 1993

D. Other documents of interest

Informe sobre el incidente de Porco Review

28. Review of the Porco mine tailings dam burst and associated mine waste problems, Pilcomayo Basin, Bolivia
Macklin M.G., Preston D. y Sedgwick (Universidad de Leeds, School of Geography) and Payne A.I. (Marine Resource Assessment Group Ltd.)
ODA - 1996
29. Informe final sobre las acciones ejecutadas por COMSUR en el derrame de colas de Porco
COMSUR S.A. - 1996
30. Informe final. Dique de colas de Porco
Ministerio de Desarrollo Sostenible y Medio Ambiente - 1996
31. Los recursos hídricos en Bolivia y su dimensión ambiental
Victor Ricaldi R., Carlos Flores M. Y Leonardo Anaya J.
USAID Bolivia
1992

E. Documents that have not been found

32. Mina Morales Tirzo. Contaminación de aguas en Tupiza
Proyecto Sucre Ciudad Universitaria - 1992
33. Información general sobre la contaminación que produce la actividad minera en Potosí e inventariación de las plantas de concentración de minerales.
Medmin. 1995
34. Background of the Bolivian mining, agriculture and manufacturing sectors.
The World Bank. Bateman D. 1992
35. Taller sobre Contaminación del Medio Ambiente en Bolivia - 1985.

Articles:

- "Investigación sobre la contaminación originada por la minería en Bolivia" of Ríos Paz Soldán C.
- "La contaminación originada por la industria en Bolivia" of Díaz Benavente J.
- "Contaminación ambiental provocada por la industria metalúrgica instalada en Bolivia" of García Rivera.

36. Informe sobre el sector boliviano de las cuencas de los Ríos Bermejo y Pilcomayo
Díez Flores, Gustavo A.
Sociedad Regional de Ciencias Humanas, Montevideo 1985
37. Para seleccionar las actividades e inversiones prioritarias en manejo del medio ambiente en comunidades mineras de Bolivia
Ayres W.S. y K. Anderson.
World Bank - Environmental Department - Washington - 1996
38. Environmental management of mining companies in Bolivia: implications for environmental and industrial policies aiming at sustainable growth in low income developing countries
CEMYD - 1992
39. Bolivia: industrial pollution mitigation study, progress report
SGAB-Geobol - 1992
40. Una encuesta de la pesquería de sábalo del Río Pilcomayo en el mes de julio de 1986.
Payne, A.I.
Overseas Development Administration and Department of Biological Sciences at Coventry Manchester Polytechnic. U.K. - 1986
41. Estudios Técnicos del Río Pilcomayo: Estudio del impacto ambiental del dique de distribución sobre el Río Pilcomayo situado entre los departamentos de Boquerón (Paraguay) y Ramon Lista (Argentina)
Technical Assistance of the European Commission's Aid and Cooperation Actions in Developing countries in Latin America, the Mediterranean and Central and Eastern Europe
EC Request 4234 - 1995

ANNEX 3 :
DETAILED BIBLIOGRAPHY

ANEXO 3: DETAILED BIBLIOGRAPHY

I. Documents that have been analyzed in a detailed way

I.A. Evaluation of mining pollution in Bolivia or of the Pilcomayo River Basin

2. Rio Pilcomayo:

- Estudio sobre la concentración de plomo y otros metales tóxicos en músculos, visceras, huesos y cuerpo entero del sábalo (*Prochilodus platensis*).
- Estudio sobre la concentración de plomo y protoporfirina de zinc en la sangre de los guaraníes.
- Determinación de plomo en sábalo, peces enteros y diferentes partes, y análisis de sangre en las poblaciones indígenas guaraníes del Itika Guasu.

**Russel Groves, Melanie Quevillon y Roxana Castro
CER-DET y QPID - 1997**

Comments:

Good quality work with precise data about concentrations of toxic elements in humans and fish. Deficiencies in the Spanish version.

It corresponds to an investigation process that began in 1995, that will allow to determine clearer tendencies in the future.

- 5. Informe sobre los daños causados a los agricultores por la contaminación del Río Pilcomayo – 1997**
Epifanio Pacheco C.
Prefectura del Departamento de Chuquisaca

Comments:

This document is one of the few studies oriented to evaluate the damages caused by water pollution to the agricultural and livestock sectors. The terms of reference of this survey clearly state that it should allow to determine the social and economic impacts of pollution from mining activities, particularly in quantitative terms.

- 6. Evaluación del grado de contaminación en aguas y suelos de las principales cuencas menores del Departamento de Potosí**
U.A.T.F.
FONAMA - 1996

Comments:

This survey is the product of one of the largest investments never realized before by the Bolivian State to obtain information and data about the mining pollution issue of the PRB.

8. **Análisis del impacto socio-económico de la contaminación del río de La Ribera-Pilcomayo**
Lic. Jaime Hinojoza D. and Lic. Samuel Rosales R.
MEDMIN - 1995

Comments:

This document presents interesting information and data about the socio-economic and environmental situation found in 23 peasant communities located on the Pilcomayo River banks. It refers to human health, livestock and agricultural production as well as to wildlife and aquatic fauna.

13. **Informe de misión sobre la contaminación de aguas por la explotación minera en las regiones de Uncía y Otavi – Departamento de Potosí, Bolivia**
PAC
European Community Commission - 1991

Comments:

Interesting report based on visits and samplings realized in a very short period of time, if the extension of the surveyed area is considered. However, it provides data of quality over water and agricultural products, and gives a good idea of the situation.

It also suggests attractive solutions to the problems.

15. **Impacto ambiental de la actividad minera de Comibol en Bolivia**
Duran de la Fuente H. and Sergio Castro F.
Banco Mundial - 1989

Comments:

A useful analysis oriented to face the problems caused by COMIBOL mining activities. Precise information and data of the Treatment Plants of La Palca, Telamayu, Vetillas, Velarde and Tatasi. Concrete recommendations are presented for those operations of COMIBOL.

I.B. Pilcomayo river basin or sub-basin diagnosis

19. **Balance hídrico superficial de la Cuenca del Pilcomayo**
Ricardo Arellano Albornóz
PHICAB - 1988

Comments:

A professional and scientific work that questions the lack of data about aspects which should be relevant for any good monitoring system of the pollution of the PRB. It provides data on the water balance of the basin and the limitations suffered by SENHAMI.

20. Cuenca del Río de La Plata – Aprovechamiento múltiple de la cuenca del Río Pilcomayo

OEA

Governments of Bolivia, Argentina and Paraguay – OEA - PNUD - 1977

Comments:

An extended work that offers a quite integral view about the social, economic and environmental situation, found more than 20 years ago. Among its main objectives, it intends to establish solid basis, in terms of data, information, and recommendations, in order to promote the sustainable management of the PRB.

I.C. Proposition of solutions and projects

23. Estudio de factibilidad para la construcción de un dique de colas en Potosí – Bolivia

Golder Associates

MEDMIN - 1996

Comments:

A good work that presents a technical solution to the extraordinary pollution caused by the mining sector located in and around the city of Potosí. Some practical aspects could be studied even deeply; particularly in respect to the pollution by dissolved elements, the common administration of the proposed tailing dam and the protection of the site in the long term.

25. Evaluación ambiental de los sectores minero e industrial

SGAB y Secretaría de Medio Ambiente y Ministerio de Minería y Metalurgia

Gobierno de Suecia y Banco Mundial - 1993

Comments:

Survey characterized by excellent quality. Absolutely necessary for anyone interested in the issue of pollution in Bolivia.

I.D. Other documents of interest

28. Revista de la ruptura del dique de la mina de Porco y problemas asociados con los desechos minerales en la cuenca del Pilcomayo

Macklin M.G., Preston D. y Sedgwick C. (Universidad de Leeds, Escuela de Geografía) y Payne A.I. (Grupo de Valoración de Recursos Marinos)

ODA - 1996

Comments:

A short survey that is very interesting because of the concrete, and objective information offered. It alerts about the fish pollution (by lead) as far as Potosí as Villamontes and about the risks associated with the huge amounts of toxic materials deposited in the river beds of the PRB.

II. Documents that have been analyzed in a global way and commented

II.A. Pilcomayo river basin or sub-basin diagnosis

1. Contaminación ambiental en los Cintis

Murillo, J.-C. Bazán and O. Vera.

FOCHMADE and Universidad de San Francisco Xavier de Chuquisaca - 1997

Comments:

This report offers some data about the water quality of the Camargo, Tunusla, San Juan del Oro and Camblaya rivers. The presentation is poor and there are mistakes related to the extension of some areas (it is indicated that the extension of the PRB in Chuquisaca is 2.400 km² instead of some 31.000 km²).

Furthermore, interpretations referring to the impacts of pollution are based upon only six water samples collected on December 12 of 1996 and assess the pollution levels of four rivers. The influence of variables such as precipitation, soil quality, etc. upon the parameters evaluated are not considered. Finally, it relates the burst of the Porco dam with those analytic results, which shows a high level of subjectivity on the part of the authors.

3. Río Pilcomayo: Estudio sobre la concentración de plomo en sangre humana y las diferentes partes del sábalo

Russel Groves, Melanie Quevillon, Roxana Castro and Delfina Morales de Arnéz

FOBOMADE, FIA and Prefectura del Departamento de Tarija - 1997

Comments:

It is the third report of a series of surveys realized by the same team. It is a small document (13 pages plus annexes) which suits to be used with document 2. It ratifies the need to strengthen the capacity of the national labs in order to increase the trust on the analytic works done in Bolivia. (see detailed evaluation of document 2).

4. El Río Pilcomayo: una evaluación de la contaminación de metales en el pez

Sábalo, un alimento básico para los Guaraníes del Itika Guasu

Melanie Quevillon, Christina Gibb y Jonathan Dogterom

QPID, CER-DET y F.I.A. - 1997

Comments:

Good work presenting usable data and information referring to the PRB pollution issue and that makes part of a series of surveys mentioned in the previous comment (document 3). The report indicates the existence of pollution risks of the Pilcomayo River in the Itika Guasu area.

7. Memoria del Ier encuentro internacional sobre el Río Pilcomayo

CER-DET – FOBOMADE – F.I.A. - 1996

Comments:

This document does not have any structure and report verbal interventions and discussions related to the Caipipendi Dam Project and to issues referring to the PRB from the perspectives of Argentina and Paraguay. A lot of comments and ideas are difficult to use.

**9. Problemática integral del Río Pilcomayo
FOBOMADE and CER-DET - 1994**

Comments:

Document characterized by a very deficient presentation and structure. It reports verbal interventions realized during a workshop referring to the PRB issue. It particularly focuses on fishing, monitoring of pollution and cultural conflicts within the indigenous society that would be affected by the Caipipendi Dam Project.

**10. Muestreo, análisis y evaluación de muestras de sangre de pobladores de la zona de La Lava, P. Linares, Potosí.
PIIQ Oruro
PACC Potosí - 1994**

Comments:

It reports a unique experience in this region (Linares Province). Lamentably, some contradictions appear in the interpretations. Analytical results are also in discussion due to the fact that samples from supposedly not affected people show higher concentration of toxic elements than that of people living of the banks of the La Lava River.

It is said that the major risks are related to excessive levels of cadmium, lead and arsenic.

**11. La minería y el medio ambiente - Estudios ambientales en las regiones de Toropalca y Andacaba-Cumurana-La Lava (Department of Potosí)
Lothar Hahn
Proyecto de Cooperación Geológica Boliviano-Alemán - 1993**

Comments:

Interesting assessment ratifying serious pollution problems in soils and water resources. Lamentably, it is based on samplings realized within less than ten days, so that the investigation is excessively short. The influence of factors such as precipitation and river flow are not considered, so that the context within which the pollution levels were registered are no known.

Some social and environmental aspects related to pollution are mentioned, but quite superficially. It reports the existence of social conflicts and alerts upon the high level of concentration in arsenic, zinc and mercury in soils and of copper and cadmium in subterranean water consumed by people in the La Lava sub-basin.

16. An environmental overview of the mining sector in Bolivia

Bell A. V.

Nolan, Davis and Associates Limited

Report to the World Bank - 1988

Comments:

Excessively short mission (in function to its objectives) oriented to inform The World Bank on what should be done to face mining pollution in Bolivia. It gives a quite clear idea of the nature and intensity of environmental problems associated with mining in the sub-basins of San Juan del Oro and Cotagaita in 1988.

This assessment does not consider the socio-economic impacts of pollution, ratifies the existence of severe physical alteration of streams and the direct discharge of polluted effluents to the rivers of that area.

17. Efectos, Alcances y magnitud de la contaminación de aguas dentro el área de influencia del Proyecto San Juan del Oro

Nilda Fernícola

PNUD – Proyecto BOL/80/001 - 1983

Comments:

The report informs over the existence and effects of processing plants and mines activities in the intervention area corresponding to a significant public project of CORDEPO. However, the document is difficult to use because of deficiencies in the presentation, as well as in the content; no explanation of the methodology, no pagination, no date, etc...

The recommendations are excessively general and inapplicable; as an example, it is suggested that processing plants should analyse water every day before and after using it.

18. El Río Pilcomayo – Las características de la Cuenca y la calidad del agua dentro de la Zona propuesta de inundación de la represa Caipipendi en la Zona Guarani, Itika Guasu

Tony Brown, Stephen Keith and Anna Wilkinson

QPID – CER-DET - FOBOMADE - 1995

Comments:

Alert about the Pilcomayo River pollution by lead, even at large distances from the mining areas. With respect to other heavy metals, it is said that water quality is good. However, a serious limitation of the survey is that it is very short in time and based on just five samples.

II.C. Proposition of solutions and projects

21. Sistema de tratamiento pasivo del agua de riego para la comunidad de La Lava – Fase I

Ricky Collins

MEDMIN – PAC/C - 1996

Comments:

Detailed and concrete proposal referring to the implementation of a passive water treatment system adapted to the prevailing socio-economic conditions. Lamentably, the report does not inform on the potential impacts of the proposed system in socio-economic terms.

It informs about risks of pollution of the subterranean water resources used by local dwellers, particularly by arsenic, cadmium, selenium. Pollution would also put agriculture at risks, throughout the use of water for irrigation, because of excessive levels of cadmium, manganese and zinc in the Khuchu Ingenio River and of aluminium, cobalt, manganese and zinc in the Andacaba River (called Kumurana in document 13).

It also expresses that Bolivian regulations referring to the chemical quality of water should be questioned.

22. Manejo Equilibrado y Sostenido de la Cuenca del Pilcomayo
Lic. Wolfgang Maier and Ing. Epifanio Pacheco C.
FOPROPE - 1996

Comments:

This document presents many statements without the required arguments, showing a high level of subjectivity on the part of the authors. As an example, it is mentioned that water consumption from the Pilcomayo River is killing men; animals and plants. Some analytical results and, overall, their corresponding interpretations seem untrustable.

Another example of subjectivity is the following: statements on a serious pollution process are based on the comparison of two samples which should not be compared because they were collected at different places, in different times of the year (September and November) and with a fifteen years period of interval (1980 and 1995) by different laboratories.

24. Problemas del Río Pilcomayo: soluciones planteadas
Ing. Ivan Medina H.
FOBOMADE - 1996

Comments:

Interesting statement on the seriousness of the physical pollution of the Pilcomayo River caused by the inappropriate management of the basin, particularly, by peasants.

It must be said that the main problems of fishing in the lower part of the basin are attributed to constructions made on the Argentine and Paraguayan side of the basin and to soil erosion in the upper part of the basin.

Two of the eight proposals made by the authors refer to chemical pollution. However the majority refer to measures that would reduce soil erosion and the effect of the constructions existing outside Bolivia.

Mention is made of the existence of elements such as arsenic, mercury and fluorine, as well as of the inexistence of zinc in the Pilaya River.

Nothing is stated about the social and economic impacts of mining pollution except a brief mention to some specific risks such as genetic problems and negative effects of the food chain.

Finally, it is indicated that some 110 km above Villamontes, the waters of the Pilcomayo River are good for human consumption (after simple desinfection).

II.D. Other documents of interest

- 29. Informe final sobre las acciones ejecutadas por COMSUR en el derrame de colas de Porco**
COMSUR S.A. - 1996

Comments:

The burst of tailing dam "B" of the concentration plant of Porco (Department of Potosí) owned by COMSUR, on August 29, caused the leakage of between 200 and 300 thousand cubic metres of tailings into the Toropalca-Tumusla sub-basin.

This is one of the report elaborated after the event. Serious deficiencies appear in the redaction, as well as expression of subjectivity. Finally, it helps to know what kind of action were assumed by COMSUR to mitigate the corresponding effects.

- 30. Informe final. Dique de colas de Porco**
MDSMA - 1996

Comments:

This document constitutes one of the reports elaborated after the tailing dam burst of Porco (see previous comment). It clearly demonstrates subjectiveness on the part of the representatives of the public sector.

- 31. Los recursos hídricos en Bolivia y su dimensión ambiental**
Victor Ricaldi R., Carlos Flores M. and Leonardo Anaya J.
USAID Bolivia - 1992

Comments:

A voluminous report of the interventions made by national and international experts during a workshop referring to water resources and its environmental aspects.

The articles are based on regional experiences and related to surveys of water quality and water pollution, watershed management and strategies for the planning and regulation of water resource uses.

III. References of documents that the mission could not revise (or only parts are available)

III.A. Evaluation of mining pollution in Bolivia or of the Pilcomayo River Basin

12. Impact of the minerals industry on the environment in some areas of the departments of Oruro and Potosí: a preliminary study of stream waters and sediments.

Noras P., Solis G. and Torrico V.

MMM: Mining Sector Rehabilitation Project - 1992

Comments:

Short survey covering various regions well-known for their mining tradition in the departments of Oruro and Potosí. Among the conclusions, it is stated that because of poor engineering of disposal systems of the mines and mills, on the one hand, and of the discharge of untreated process and mine waters on the other hand, all the rivers draining operating mining areas, without exceptions, are chemically contaminated.

14. Primera Mesa Redonda sobre "Contaminación de Aguas en Bolivia"
1983

Three articles:

- Contaminación originada por la industria minera de Narciso Cardozo R.
- Contaminación de la industria minera de Mario Sahonero I.
- Legislación de Waldo Vargas B.

Comments:

These articles can be found at the library of LIDEMA.

III.C. Proposition of solutions and projects

26. Minería y gestión ambiental en Bolivia

Javier Salinas R.

SENMA - 1993

Comments:

Important document due to its analysis of the structural causes and solutions (policies and regulations) to the pollution problems produced by the mining sector. Concrete example of pollution issues, such as those of the Empresa Minera Unificada de Potosí, and of the Toropalca and La Lava sub-basins.

27. Proyecto Kumurana: estudio para el tratamiento de aguas de mina y efluentes del ingenio

I.I.M.M.

Empresa Kumurana - 1993

Comments:

Project profile on pollution mitigation that appears as a result of a conflict between a small mining enterprise and rural villages around La Lava, Potosí.

The idea did not result as expected due to the temporal closure of the enterprise caused by serious economic problems. It has been commented that in the present political and legal context, the operation costs of such systems would not be acceptable for those enterprises assuming them.

III.D. Other documents

**32. Mina Morales Tirzo. Contaminación de aguas en Tupiza
Proyecto Sucre Ciudad Universitaria
1992**

Comments:

This reference is mentioned in document 24. Tirzo Morales lives in Sucre and works for the "Sucre Ciudad Universitaria" Project (see annex 4).

**33. Información general sobre la contaminación que produce la actividad minera en Potosí e inventariación de las plantas de concentración de minerales
MEDMIN - 1995**

Comments:

This report is cited in document 23 and is probably available for consult in MEDMIN - COSUDE (see annex 4).

**34. Background of the Bolivian mining, agriculture and manufacturing sectors
Bateman D.
The World Bank - 1992**

Comments:

This reference is mentioned in Appendix II of document 25. It may probably be obtained at The World Bank in Washington - USA (email: books@worldbank.org).

35. Taller sobre Contaminación del Medio Ambiente en Bolivia – 1985

Articles:

- 'Investigación sobre la contaminación originada por la minería en Bolivia' of Ríos Paz Soldán C.
- 'La contaminación originada por la industria en Bolivia' of Díaz Benavente J. ...
- 'Contaminación ambiental provocada por la industria metalúrgica instalada en Bolivia' of García Rivera

Comments:

This reference is cited in Appendix II of document 25.

- 36. Informe sobre el sector boliviano de las cuencas de los Ríos Bermejo y Pilcomayo**
Díez Flores, Gustavo A.
Sociedad Regional de Ciencias Humanas - Montevideo - 1985

Comments:

This document exists in the library of the North American Congress specialised in Latin American Studies (HLAS).

- 37. Para seleccionar las actividades e inversiones prioritarias en manejo del medio ambiente en comunidades mineras de Bolivia**
Environmental Department - World Bank - Washington.
Ayres W.S. y K. Anderson.
1996

Comments:

It should be possible to obtain this report at the World Bank in Washington - USA (email: books@worldbank.org).

- 38. Environmental management of mining companies in Bolivia: implications for environmental and industrial policies aiming at sustainable growth in low income developing countries**
CEMYD - 1992

Comments:

This reference is cited in Appendix II of document 25.

- 39. Bolivia: industrial pollution mitigation study, progress report**
SGAB-Geobol
Geobol
La Paz
1992

Comments:

This reference is mentioned in Appendix IV.1. of document 25 and has been elaborated in association with the consulting firm Swedish Geological AB (SGAB) that has its own homepage in Internet. It is probably possible to find this report in SERGEOMIN.

- 40. Una encuesta de la pesquería de sábalo del Río Pilcomayo en el julio de 1986.**
Payne, A.I.
Overseas Development Administration and Department of Biological Sciences at Coventry Manchester Polytechnic. U.K. - 1986

Comments:

This reference is cited in documents 2 and 18.

- 41. Estudios Técnicos del Río Pilcomayo: Estudio del impacto ambiental del dique de distribución sobre el Río Pilcomayo situado entre los departamentos de Boquerón (Paraguay) y Ramon Lista (Argentina)**
Technical Assistance of the European Commission's Aid and Cooperation Actions in Developing countries in Latin America, the Mediterranean and Central and Eastern Europe
EC Request 4234 - 1995

Comments:

This reference is mentioned in document 24.

ANNEX 4 :
INSTITUTIONS AND EXPERTS

ANNEX 4: INSTITUTIONS AND EXPERTS

The next lists correspond to some references of persons and institutions working or having worked with PRB pollution related-issues

INSTITUTIONS

NAME	CITY	POST BOX-FONE
ASE	Sucre	43730
WORLD BANK	La Paz	356844
CRACH	Sucre	51143
CADEMIN	Potosí	24563
CDR	Potosí	32527-32424
CEPROMIN	Potosí	26396-27295
	La Paz	359402
CER-DET	Tarija	35471
COMSUR	Potosí	25551
	La Paz	361018-362080
CONSEJO MUNICIPAL	Potosí	22721-23142
CSJO	Tupiza	446
DANIDA	Potosí	42066
DRU	Potosí	23745
EC	La Paz	410155-410088
FDC	La Paz	379430-360951
FOBOMADE	La Paz	353048
FOCHMADE	Sucre	60477
FONAMA	La Paz	392367-392370
IBBA	Potosí	27324
IIMM	Oruro	51133-52740
INSO	La Paz	370864
INSTITUTO DE ECOLOGIA - UMSA	La Paz	799459-792582
IPTK	Sucre	62447-61352
ISALP	Potosí	24192-26228
LIDEMA	La Paz	324909-353352
MEDMIN - COSUDE	La Paz	711213-323174
MDSP	La Paz	367449-372063
Recursos Naturales	La Paz	355694
Calidad Ambiental	La Paz	392936-369389
Medio Ambiente	La Paz	413383-410936
Proyectos Internacionales	La Paz	375899
ORSTOM	La Paz	355824-322267
PAC	Potosí	42013-42028
PASTORAL SOCIAL	Potosí	24274-26893
PIIQ-UTO	Oruro	61008
PREFECTURA DE POTOSÍ	Potosí	27358
Recursos Naturales	Potosí	27344
PREFECTURA DE CHUQUISACA	Sucre	53105
Recursos Naturales	Sucre	52288
PROMETA	Tarija	33873
PRONALDES	La Paz	374746
SENHAMI	La Paz	355824
SENHAMI	Sucre	41605
SERGEOMIN	La Paz	322022-377319

SERGEOMIN	Oruro	51133
SOPE	Potosí	27725
SPECTROLAB Laboratory	Oruro	60008
UATF	Potosí	27328
Geología	Potosí	27311
Minas	Potosí	27320
UNDP	La Paz	358589-358590
UNEP	La Paz	391379-391380
USAID	La Paz	320838-320896
ZONISIG	Sucre	60865

EXPERTS

NAME	CITY	FONE
Ballivian Oscar	La Paz	390780
Carrasco Juan Carlos	Potosí	24129
Cárdenas Agustín	La Paz	375899
Castro Humberto	Potosí	27311
Collins Ricky	La Paz	361018-362080
Coronado Felipe	Oruro	61008-52462
Cortez Guillermo	La Paz	323174
Hentschel Thomas	La Paz	785138-323174
Isla Victor	Potosí	24333-27320
Michel Jose-Antonio	Sucre	25002-60865
Mina Tirzo	Sucre	53969-62773
Paz Bernardo	La Paz	411834
Quintana Ernesto	Potosí	25165
Quintanilla Jorge	La Paz	792238
Román Eddy	Potosí	26621
Salinas Javier	La Paz	432618
Schollaert Alain	Sucre	62447-53535
Taucer Evelyn	La Paz	785138-323174

LABORATORIES

NAME	CITY	POST BOX-FONE
AGUA ANDINA	Oruro	2430
BONDAR CLERG	Oruro	40123 (Fone)
CDR	Potosí	32527 (Fone)
ESPECTRO-LAB	Oruro	252
IIQ - UMSA	La Paz	303
ISLDS	La Paz	M10362
INSO	La Paz	370864 (Fone)
INSTITUTO DE ECOLOGIA	La Paz	10077
INSTITUTO DE INGENIERIA - UMSA	La Paz	1755
SAGUAPAC	Santa Cruz	3284
SERGEOMIN	La Paz	322022 (Fone)
SERGEOMIN	Oruro	51133 (Fone)
UATF	Potosí	27311 (Fone)
UMSS	Cochabamba	992
YPFB	Cochabamba	684

TABLE OF ACRONYMS

TABLE OF ACRONYMS

ASE	Asociación Sucrense de Ecología - Sucre
ABIS	Asociación Boliviana de Ingeniería Sanitaria
BID-IDB	Interamerican Development Bank
CADEMIN	Cámara de Minería
CDR	Centro para el Desarrollo Regional - Potosí
CEPROMIN	Centro de Promoción Minera – La Paz
CER-DET	Centro de Estudios Regionales para el Desarrollo de Tarija
COMIBOL	Corporación Minera de Bolivia
COMSUR	Compañía Minera del Sur
CORDEPO	Corporación Regional de Desarrollo de Potosí
COSUDE	Swiss Cooperation for Development
CRACH	Cámara Agropecuaria de Chuquisaca
CSJO	Cotagaita San Juan del Oro project - Potosí
EC	European Community
ETESA	Equipo Técnico Educativo Sergio Almaraz - Potosí
DANIDA	Danish Cooperación for Development
DRU	Rural Development Group (national and departemental)
FDC	Fondo de Desarrollo Campesino
FIA	Fondo de Intercambio Ambiental
FOBOMADE	Foro Boliviano para Medio Ambiente y Desarrollo
FOCHMADE	Foro Chuquisaqueño para Medio Ambiente y Desarrollo
FOPOMADE	Foro Potosino para Medio Ambiente y Desarrollo
FOPROPE	Fortalecimiento a la Producción en Pequeña Escala
FONAMA	National Fund for the Environment
IBBA	Instituto Boliviano de Biología de la Altura
IGM	Instituto Geográfico Militar
IHH	Instituto de Hidráulica e Hidrología de la UMSA - La Paz
IIMM	Instituto de Investigación Minero Metalúrgica – Oruro
IIQ	Instituto de Investigación Química
INE	Instituto Nacional de Estadísticas
INSO	Instituto Nacional de Salud Ocupacional
IPTK	Instituto Politécnico Tomás Katari - Sucre
ISALP	Investigación Social y Asesoramiento Legal – Potosí
ISLDS	Instituto de Servicios de Laboratorio de Diagnóstico en Salud
LIDEMA	Liga de Defensa del Medio Ambiente – La Paz
MDSMA	Ministry of Sustainable Development and Environment
MDSP	Ministry of Sustainable Development and Planning
MEDMIN	Manejo Integrado del Medio Ambiente en la Pequeña Minería
MMM	Ministry of Minery and Metallurgy
ODA	United Kingdom Overseas Development Administration
OEA	Organización de Estados Americanos
ORSTOM	French Institute in Scientific Investigations for Development Cooperation
PAAB	Environmental Action Plan of Bolivia
PAC	Programa de Autodesarrollo Campesino (EC Commission)

PHICAB	Proyecto Hidrológico y Climatológico de Bolivia
PIIQ	Programa de Investigación Ingeniería Química -- UTO - Oruro
PNUD	United Nations Development Program
PRB	Pilcomayo River Basin
PROMETA	Protección Medio Ambiente Tarija
PRONALDES	Programa Nacional de Lucha contra la Desertificación y la Sequía
QPID	Queen's Project on International Development -Canada
SENAMHI	Servicio Nacional de Meteorología e Hidrología
SES	Swedish Environmental Systems
SENMA	Secretaría Nacional de Medio Ambiente
SERGEOMIN	Servicio Geológico Minero
SGB	Swedish Geological AB
SOPE	Sociedad Potosina de Ecología
UATF	Universidad Autónoma Tomas Frías - Potosí
UMSA	Universidad Mayor de San Andrés - La Paz
UMRPSFXC	Universidad Mayor, Real y Pontificia de San Francisco Xavier de Chuquisaca
UMSS	Universidad Mayor de San Simón - Cochabamba
UNEP	United Nations Environmental Program
USAID	United States Agency for International Development
UTO	Universidad Técnica de Oruro
ZONISIG	Proyecto de Zonificación Agro-ecológica y Establecimiento de una Base de Datos y Red de Sistema de Información Geográfica en Bolivia

Complementary report

I. Introduction

In this complementary report, the most significant data encountered in the documents 2,3,4,8,13 and 15 are presented. In each of these cases, the authors tend to demonstrate an adequate level of objectivity and/or have avoided or recognised technical errors and/or methodological difficulties. However, as it has already been mentioned, those data should be used with precaution because they have mostly been obtained over very short periods of time and/or without considering a series of variables closely related to the evaluated parameters and outside any monitoring system. Moreover many data are lacking about the regional context or about the studied area which is particularly worrying and makes difficult the presentation of correct conclusions about the socio-economic impact of the pollution generated by mining activities in the PRB.

The first three documents (2,3,4) refer to different studies about the concentration of toxic metals in human blood and silver fish. As it can be observed in the description of these documents, there are no sufficient data to consider that human health problems can be used as consistent parameters to alert public opinion about the impact of pollution by metal accumulation. The authors recognize that diseases associated with lead are not specific of lead accumulation and that no tendencies can be determined over only two or three years of investigations.

Document 8 is unique because it is based on interviews with concerned people who assess pollution problems in function to their own criteria. Rural dwellers have the possibility to base their statements upon what they have lived and observed, sometimes over very large periods of time. However, it seems quite obvious that such observations are not well quantified and also very subjective. So they would be used jointly with scientific measures and their limits would need to be identified and described.

Documents 13 and 15 are the results of other short investigations realized in 1990 and 1989. They offer an idea of the situation that was prevailing some years ago, but it would obviously be interesting to compare that situation with the present one. They do not help much to assess socioeconomic impacts but constitute relevant references for institutions interested in improving the PRB management.

II. Complementary assessment and interpretation

II.A. DOCUMENTO N° 2

Pilcomayo River

- Studies about the lead concentration and other toxic metals in muscles, inner organs, bones, and entire bodies of the silver fish (*Prochilodus platensis*)
- Studies about the concentration of lead and Zinc Protoporphine in the guaranian's blood.
- Determination of lead in the silver fish; entire fish; and different parts; and blood tests of the guaranians of the Itika Guasu.

**Russel Groves, Melanie Quevillon y Roxana Castro
CER-DET and QPID - 1997**

Those three studies refer to the PRB after the junction of the Pilcomayo and the Pilaya rivers in a small area situated in the Department of Tarija, close to the Department of Chuquisaca.

There are very few information about this area (this is the same area for documents 2, 3 and 4). According to Document 18, the population density, in the area proposed for the construction of the Caipipendi dam (part of the studied area), is estimated in 6 inhabitants per square kilometer.

Even if fish production is variable in time, mainly due to climatic factors, a constant diminution of fish production has been observed between 1982 ((3000 m.t.) and 1990 (860 m.t.). It is partially attributed to over-fishing, fishing with explosives, droughts and deforestation.

First study

Impact on public health :

Considering the average number of fishes consumed by each inhabitant (5.8 per week) and the average lead concentration observed in fish muscles (0.05 ug Pb/gr.), the investigators consider that there is no risk for human population. To reach the level considered as permissible limit, consumers should eat some 34 fishes per day.

Impact on fishery:

In entire fishes, the average levels of the chemical elements considered in the analysis were the following:

Element	Average level observed	Comments
Lead	6.96 ppm	Average level observed in 1996 was 5.56 ppm The level observed is 15 to 20 times higher than what is observed near Villamontes Highest concentration affects bones and kidneys *
Arsenic	4.6 ppm	Highest concentration affects bones and kidneys *
Nickel	0.75 ppm	
Cadmium	0.1 ppm	Highest concentration affects kidneys *
Chromium	0.36 ppm	Highest concentration affects bones *
Copper	4.9 ppm	Highest concentration affects kidneys *

* Comparing the concentration of each element in muscles, kidneys and bones, the highest concentration observed affect particularly certain parts of the fish.

Second study

Impacts on human health

Element	Average level observed	Comments
Lead	4.94 ug/dl	The level observed seems to be normal

Third study

Average levels of lead concentration registered in human blood

Average lead concentration	Comments
16 ug/100 ml	Within normal levels but without any comment about the large difference with the second study result (4.94 ug/100 ml)

Average levels of lead registered in entire fishes

Year	Average concentration observed	Other comments
1996	5.56 ppm	Authors statements oppose the result observed in 1997 and indicate that fish may be consumed without any risk for human health.
1997	1.49 ppm	

Complementary observations

In the second study, Zinc Protoporphirina or ZPP has also been considered as an analytical parameter but investigators state that it is not a good indicator of intoxication by lead. Even without informing about the permissible concentration levels, the authors of the third study state that a concentration level of 16 ug/dl is normal. However, this is opposed by experts such as Philip J. Landrigan and Andrew C. Todd (Lead Poisoning, 1994). They mention that the Centers for Disease Control and Prevention of the USA consider that a blood lead level of 10 ug/dl or higher constitutes a problem for children and that lead causes neurological damage to fetuses at blood lead levels as low as 15 to 20 ug/dl. Anyway, the authors recommend the monitoring of this parameter and this fact demonstrates that there is a potential risk for human health.

II.B. DOCUMENT 3

Rio Pilcomayo: Estudio sobre la concentración de plomo en sangre humana y las diferentes partes del sábalo
Russel Groves, Melanie Quevillon, Roxana Castro and Delfina Morales de Arnéz
FOBOMADE, FIA and Prefectura of the Department of Tarija - 1997

The investigation exactly covers the same area as document 2.

Average lead concentration registered in entire fishes

Laboratory	Average lead concentration	Comments
Dynacare (Canada)	6.96 mg/Kg	The authors seem to question the validity of the results obtained in La Paz
I.B.T. (Bolivia)	1.48 mg/Kg	

Average levels of lead registered in human blood

Average lead concentration	Other comments
5.2 ug/100 ml	Normal levels. No comments has been found respect to the fact that this value is 3 times lower than that mentioned in study 3 of document 2.

Average lead concentration registered in entire fishes in different locations

Location	Average lead concentration	Comments
Villamontes		0.73 mg/Kg
Puerto Margarita	18.93 mg/Kg	Between Potosí and Villamontes
Yuquimbá		1.48 mg/Kg

Complementary observations

It clearly appears that the analytical results present problems. Resuming, it must be pointed out that:

- The results referring to entire fishes are extremely divergent between laboratories and no explanation is given.
- Important divergences also exist between the results referring to human blood presented in documents 2 and 3.
- Respect to the results referring to human blood, the investigators indicate that, following the Bolivian Laboratory, sample 6 shows intoxication by lead and samples 17 and 35 demonstrate dangerous exposition to lead. At the same time, they point out that, following the results obtained in Canada, only one sample shows a high level of lead concentration. Lamentably, the number of this sample and the level of concentration are not specified.
- Concerning the extreme result obtained in fishes of Puerto Margarita (lead concentration 15 to 20 times higher than in the two other locations) it is considered that an error could have occurred.

I.I.C. DOCUMENT 4

El Río Pilcomayo: una evaluación de la contaminación de metales en el pez Sábalo, un alimento básico para los Guaraníes del Itika Guasu
Melanie Quevillon, Christina Gibb and Jonathan Dogterom
QPID, CER-DET and F.I.A. - 1997

The report has been edited in 1997, but the investigation was realized between June and August of 1996 in the same area as documents 2 and 3.

In this report, as well as in the other ones, no information is given about permissible limits referring to lead concentration in entire fish and in human blood. However, it is pointed out that children absorb 50 % of the lead they consume, while adults only absorb 10 %. Absorption of lead also varies depending on the concentration of calcium and iron prevailing in the organism. Lack of calcium and/or iron increases lead absorption in human.

They also report that, economically, the "Sábalo" fish is the most important species in Bolivia. It would constitute 65 to 70 % of the entire fish market in Bolivia. Fishermen working along the Pilcomayo River would earn some 410.000 dollars per year. Some 2500 fishermen, 1650 registered truckers and 170 merchants depend, at least partially, on fishery.

The average levels of metal concentration registered in fishes are synthesized in the next table

Location	As (ppm)	Cu (ppm)	Hg (ppm)	Pb (ppm)	Sb (ppm)	Zn (ppm)
Villamontes	6.08	0.05	6.82	2.11	17.26	13.31
Puerto Margarita	6.08	0.05	6.82	7.76	23.48	35.64
Yukimbia	6.08	0.05	6.82	6.82	14.48	33.48

Complementary observations

No relevant information is given to compare those results with permissible limits, except a regulation prevailing in Canada but which refers to the eatable portion of the fish. This does not apply to the results presented in the report because they refer to entire fishes.

As for documents 2 and 3, problems related with analytical results confidence and the lack of information referring to permissible limits adversely affect the survey. We could resume the observations as follows:

- No comment was found over the surprising perfect equality between results from samples obtained in different locations.
- The explanation given for the contradictory results for lead concentration obtained from a same sample is questionable; effectively, it just states that both values are so high that even the lowest is causing preoccupation. This clearly does not justify a difference of 100 % in values obtained for the unique sample that has been duplicated (1.99 and 4.03 ppm of lead).

II.D. DOCUMENT 8

Análisis del impacto socio-económico de la contaminación del río de La Ribera-Pilcomayo

Lic. Jaime Hinojoza D. and Lic. Samuel Rosales R.
MEDMIN - 1995

As indicated in its title, this report refers to the La Ribera-Pilcomayo Sub-basin, situated between the city of Potosí and "Puente Mendez".

Following Table 14 of the report, we might resume the most relevant information and data presented by the authors in the following way:

Human health	Agriculture	Stocking	Soils	Bio-diversity
Contact with water causes irritation, bleeding and/or cracking of skin	Production of carrots require 300 % more of seeds, for a lower productivity (70%)	Intestinal diseases when drinking water	Degradation of soil structure	Disappearance of vegetation on river banks
Drinking water causes intestinal and stomachal diseases	Abnormally slow growth of plants	Degradation of nails when in contact with water	Accumulation of solid elements from mining operations	Disappearance of aquatic life
	Death of plants	Low reproduction	Nutrient loss	
	Low productivity	Low productivity	Labor inefficiency	

Complementary observations

Data such as those referring to the production of carrots show a high level of subjectivity on the part of rural dwellers. No reference data exist about productivity before and after pollution has occurred. Nothing is specified about the year that has been considered, the climatic conditions prevailing when production was high, neither when production has been affected, etc...

This situation is also obvious when considering nutrient loss and degradation of soil structure; effectively, nothing is mentioned about other potential causes of those degradation processes (soil erosion, overuse, etc...).

ILE. DOCUMENT 13

Informe de misión sobre la contaminación de aguas por la explotación minera en las regiones de Uncía y Otavi – Department of Potosí, Bolivia
PAC
EC Commission - 1991

Following the report, we might resume the most relevant data in the following way:

The information presented in these tables refer to four sub-basins that are part of the Tumusla sub-basin (please see the map).

Sub-basin	Vicia faba (agricultural product) mg/kg						River algae mg/dry kg					
	Hg	Zn	Sn	Pb	As	Cd	Hg	Zn	Sn	Pb	As	Cd
Toropalca	<0.1	43	-	<25	<0.1	-	0.88	410	1.5	46	33	-
La Lava	0.07	78	-	<25	0.37	-	-	-	-	-	-	-
Puna	<0.1	27	-	<25	<0.1	-	-	-	-	-	-	-

Sub-basin - water	NaCn	Zn	Sn	Mn	Cu	pH
Kestuchi (Toropalca)		>1mg/kg		high		6.5
Caiza (Toropalca)	0.04 mg/kg		8.1mg/kg			9.1
La Lava			0.01mg/kg			6.5
Andacaba (La Lava)		high		high	7 mg/kg	2.9
Puna						6.9

Complementary observations

It must be observed that the report does not present much data sustaining the textual information. For instance, the analytical results obtained in Belgium and a part of those obtained in Bolivia have not been found in the final report.

Among the problems that affect those data lie the fact that samples have been collected at the end of the dry season, when concentration of toxic elements is, generally, extremely high. This is particularly obvious for the Andacaba and La Lava rivers that are practically dry during that season.

Sampling has only been realized once (July, August and September of 1990), making it impossible to determine any tendency.

I.I.F. DOCUMENT 15

Impacto ambiental de la actividad minera de Comibol en Bolivia

Duran de la Fuente H. and Sergio Castro F.

World Bank - 1989

Following the report, we might resume the most relevant data, corresponding to the situation prevailing in 1989, in the following way:

Enterprise	Operations	Affected Sub-basin
Empresa Minera Unificada	Velarde mine Velarde processing plant	Pilcomayo-La Ribera
Empresa Minera Subsidiaria Quechisla	San Vicente mine Vetillas processing plant Tatasi processing plant	Cotagaita

Consumption of chemical reagents by three processing plants of COMIBOL

Processing plant	Chemical reagent (Kg/treated m.t.)		Mineral (m.t./day)		Tailings
Velarde	Xantato Z-6	0.05	Zn-Ag	240	230 m.t./day spilled to the river
	Xantato Z-200	0.06			
	Quick lime	13.97			
	Copper sulphate	1.13			
	Dow froth 1012	0.03			
Vetillas	Xantato Z-6	0.032	Zn-Ag	400	375 m.t./day spilled to the river
	Xantato Z-200	0.001			
	Xantato Z-11	0.026			
	Phosokresol	0.004			
	NaCn	0.003			
	Quick lime	29.71			
	Copper sulphate	0.86			
	Dow froth 1012	0.008			
	Aerofloat	0.001			
Tatasi	Xantato Z-6	0.031	Pb-Zn-Ag	233	230 m.t. stocked in a tailing dam
	Xantato Z-11	0.027			
	Phosokresol	0.010			
	NaCn	0.011			
	Quick lime	7.06			
	Copper sulphate	0.792			
	Dow froth 1012	0.013			
	Silicate Na	0.003			
	Zinc sulphate	0.009			
	Pine oil	0.007			

III. Conclusions

Synthesis of the complementary analysis of documents 2, 3, 4, 8, 13 and 15

I. Confirmation of the existence of socioeconomic impacts

Following document 4, it is clear that, in the medium and long term, risks of large social and economic prejudice exist. Even if this report states that the concentrations registered for arsenic, copper, antimony, cadmium, mercury and silver were low to very low, it is also indicated that lead, zinc and tin concentration levels in "Sábalo" fish were above the permissible limits.

A gross product of Sábalo fishery situated around 410.000 dollars per year may appear quite low. But placed in the context of the extreme poverty prevailing in those areas and considering that this value is referred to the price paid to fishermen, this sum does not

traduce the effective importance of this economic activity. The authors of document 4 point out that this value is underestimated because the price paid within the fishing area is excessively low compared with the price paid in cities (some three times higher). Furthermore, it appears that the employment of thousands of people should also be taken into account. In general terms, it is clear that Bolivia depends on the fishery for the food security of some parts of its territory and that the country should intent to maintain its production and quality.

Even in areas, such as those that have been considered in document 8, where population densities are low (around 4200 inhabitants living along the Pilcomayo River between Potosí and Puente Mendez which are separated by some 150 km,) it seems clear that, following rural dwellers considerations, water pollution constitutes a negative factor that complicates any regional development process.

An interesting observation refers to the arsenic level registered in *Vicia faba* (local bean) and reported in document 13. In economic terms, this plant species constitutes one of the most important agricultural products of the La Lava region. It also represents a real opportunity for rural development. It is probably unique in this area as local producers are organized around its production and exportation. For some five to ten years now, the production of *Vicia faba* has been growing constantly and now reaches more than 8000 tons produced each year in the Department of Potosí and largely in the region of La Lava. This production represents a gross product of some 3 million dollars per year. Lamentably, pollution put this very promising activity in jeopardy.

Another important issue pointed out in document 8 is referred to short, but severe pollution events. No data is given and this seems logical as the impact of such event would necessarily require an effective monitoring system to be detected and assessed. It must be argued that such isolated events obviously contribute the already intense emigration process suffered by this region.

Following the information presented in document 15, it appears that many similarities characterize the Cotagaita San Juan del Oro and La Ribera-Pilcomayo sub-basins, particularly in terms of density of mining operations, type of mineral treated and soil erosion problems. Even if environmental and social conditions differ in some way, it is probably correct to extrapolate the dramatic impacts observed around the city of Potosí with the potential impacts of mining operations situated within the Cotagaita San Juan del Oro Sub-basin.

It should be noted that this sub-basin has been much less surveyed than the sub-basins situated near the city of Potosí and that it could be advisable to investigate in a more balanced form.

II. Need for monitoring

Most investigations correspond to diagnosis and do not allow the determination of tendencies. This need for monitoring of the environmental, social and economic impacts of pollution has been commonly argued by most investigators.

The economic importance of the fish species considered in documents 2,3 and 4, in terms of traditional food systems, as well as of its place in the national fish market, justifies the monitoring of the impacts of the different factors influencing its development. The average blood lead level of 16 ug/dl observed in the population of the Itika Guasu area also justifies it.

It must also be indicated that the chemical and physical dynamics of the materials deposited in riverbeds, in the lower as well as in the upper part of the PRB, should be monitored to estimate the levels of risk for human health and fishery in the longer term.

Long term monitoring based upon an integrated approach would allow to modify the traditional tendency to assess isolated parameters.

It would, for example, be possible to put a higher emphasis upon the indirect effects of water pollution such as the loss of productivity and the degradation of the best agricultural land associated with agricultural frontier expansion in marginal areas. As it has already been mentioned, those processes constitute root causes of soil erosion, sedimentation, inundation and alluvial land destruction.

Finally, a longer investigation would be required to complete the technical and socioeconomic information about the studied area: demographic data, fishing production systems and technologies, other traditional activities, income structure, deforestation, climatic conditions, and other socioeconomic parameters useful at the time to determine the real impacts of pollution. In general terms a better knowledge could be acquired through the implementation of an efficient and integrated monitoring system.

III. Need for official norms for permissible limits

Considering the levels of lead concentration registered in human blood and in entire fishes and following the conclusions presented in document 3, it could be stated that there are no pollution impacts at present in this sector. However, it has been observed that this statement is one among many others that are made within a context characterized by a lack of data referring to lead concentration permissible limits.

In document 4, it is also mentioned that no information was found over permissible limits for zinc, tin and copper in fish. This represents a common deficiency of the analyzed documents, because it is difficult to understand how considerations are made about the risks associated with certain concentration levels in food and human blood without knowing those permissible limits.

Furthermore, it seems that those limits would need to be fixed considering the variability of many factors such as people age, gender, traditions, poverty level, etc.

Final comments

Risks of social, economic and environmental impacts associated with the PRB pollution

Even if information and data are lacking in terms of permissible limits for different population groups (pregnant women, children, etc...), following the data presented in the analyzed documentation, it is possible to estimate the risk levels associated with some toxic elements.

For the many reasons exposed in the present assessment, it is recommended to consider data presented in next table as references only.

Sub-basin	Chemical Element	Risk level (***)			
		Water	Agriculture	Health	Fishery
La Lava (fishing is not a significant economic activity)	As	High	Nd	High	-
	Hg	Medium	High	High	-
	Sb	Medium	Medium	Nd	-
	Zn	Medium	High	Medium	-
	Pb	Low	Nd	Low	-
	Cu	Medium	Medium	Low	-
	Cd	Medium	Medium	High	-
Toropalca (fishing does not seem to be or have been a significant economic activity)	NaCn	High	Low	High	-
	Mn	High	High	Nd	-
	Sb	High	Nd	Nd	-
	Pb	Low	Nd	Low	-
	As	Medium	Nd	Medium	-
	Hg	Low	Low	Low	-
	Zn	Medium	Medium	Low	-
Cotagaita (no data have been found about fishery)	Pb	High	Nd	High	-
	Zn	High	High	Medium	-
	Ag	Medium	Nd	Nd	-
Upper Pilcomayo (*)	Cd	High	High	High	****
	Sb	High	Nd	Nd	****
	Zn	High	High	Medium	****
	As	High	Nd	High	****
	Cu	High	High	Medium	****
	Pb	High	Nd	High	****
Lower Pilcomayo (**)	Pb	Low	Nd	Medium	Medium
	As	Low	Nd	Nd	Low
	Ni	Nd	Nd	Nd	Low
	Hg	Low	Nd	Nd	Nd

	Sb	Low	Nd	Nd	Low
	Cd	Low	Nd	Nd	Low
	Cr	Nd	Nd	Nd	Low
	Cu	Low	Nd	Nd	Low
	Zn	High +	Nd	Nd	Medium
	Sn	Low	Nd	Nd	Medium

* Pilcomayo between the city of Potosí and Puente Mendez

** Pilcomayo between the Pilaya River and Villamontes

*** Domestic animals are not considered because information and data are lacking. However, it remains that where toxic elements are found in water, monitoring of animal health should be implemented

**** No analytical data have been found, nor information referring to impacts of specific elements. However, rural dwellers living in the lower portion of the Upper Pilcomayo River have reported very negative impacts on fishery associated with mining pollution.

+ The first study of presented in document 2 states, that among 7 elements, zinc has been found in normal concentration. However, in the same phrase, it is stated that zinc has been found in relatively high concentration in water, following a previous study. As a special mention is made over zinc, it has been considered that the first part of the statement constitutes an error.

Nd No data available

It must be mentioned that no data, nor information, have been found over the risks and impacts associated with the spill of chemical reagents such as Xantate, Dow Froth, Aerofloat, Phosokresol and others. However, such spill has been confirmed by document 15.

Geographical areas recommended for urgent interventions

It is also possible to identify the most urgent interventions, considering the magnitude and intensity of the observed problems (please see the table referred to risk levels), population size and density, and the relevance of the economic activities that are concerned by the PRB pollution.

Population and provinces affected by pollution of the PRB, following data of INE (1992)

Department	Provinces (*)	Population density (inh./sq.km)	Total population	Area (sq/km)
Potosí cell Quijarro		2.51	37374	14810
	Nor Chichas	4.56	40944	8979
	Sur Chichas	5.83	49648	8516
	Linares	10.23	52541	5136
	Saavedra	22.17	52654	2375
	Frias	43.01	147094	3420
Chilquesaca	Ortipeza	44.71	176292	3943
	Ngri Eñiti	8.25	65860	7983

	Sur Cinti	4.61	25281	5484
	Siles	6.44	35246	5473
	Azurduy	5.61	23478	4185
	Yamparaez	21.24	31265	1472
	Zudañez	8.29	30988	3738
Tarija	Mendez	6.14	29847	4861
	O'Connor	3.35	17785	5309
	Gran Chaco	4.28	74592	17428
Total		Average: 10.36	890889	85938

* Only an undetermined portion of the population of these provinces suffer from direct or indirect impacts caused by PRB pollution. This is particularly true for Gran Chaco and Quijarro Provinces.

Comparing the total population of the Department of Potosí, Chuquisaca and Tarija, the concerned population represents the following percentages:

Department	Concerned population	Total population	Percentage concerned
Potosí/cell 380255		645459	59 %
Chuquisaca	388410	453926	86 %
Tarija	122224	291578	42 %
Total	890889	1390963	64 %

According to INE (1996), the participation of the departments of Potosí, Chuquisaca and Tarija was, respectively, of 5.36%, 7.99% and 5.81 % of the gross national product obtained through agriculture in 1993. The agricultural gross product of these three departments was, for 1993, of some 45, 67 and 48 million dollars, respectively.

Considering the gross product of 1993 coming from the agricultural sector of those departments (INE, 1996), the estimated percentages in terms of the population concerned and a constant economic loss representing half a percent * of the agricultural gross product of the region (production quality and quantity and health problems caused by the consumption of polluted products), we might intent to give an idea of the economic impact of PRB pollution.

Department	Gross Product from agriculture	Concerned over total population	Gross Agricultural Product of the concerned region	Estimated annual economic cost of pollution
Potosí/cell US\$ 45 million		59 %	US\$ 26.55 million	US\$ 132.750
Chuquisaca	US\$ 67 million	86 %	US\$ 57.62 million	US\$ 288.100
Tarija	US\$ 48 million	42 %	US\$ 20.16 million	US\$ 100.800
Total	US\$ 160 million		US\$ 104.33 million	US\$ 521.650

*Following UNDP, the annual loss of agriculture land caused by pollution and erosion, at the world level, is estimated around 1 %. It may be supposed that the annual rate loss of agricultural productivity is, at least, equal in Bolivia and in the

PRB. Considering an equal incidence of these two factors, a annual rate loss of productivity of 0.5 % could be estimated .

Considering the previous tables, it seems clear that due to the high risk levels and population density corresponding to the Upper Pilcomayo Sub-basin, this latter should be treated before other ones. However, as pollution of the Cotagaita Sub-basin has clearly been insufficiently surveyed and as it affects quite directly areas of the three departments that are characterized by a superior economic potential in terms of agriculture and fishery, it should also be intervened as soon as possible.

This does not mean, obviously, that intervention in the La Lava and Toropalca sub-basins should be delayed indefinitely. These areas also suffer serious problems and are known for the intense conflicts constantly occurring between peasants and miners.

Need for cautiousness with data and information referring to socioeconomic impacts of past and present mining operations situated in the Pilcomayo River Basin

Finally, as it has been mentioned throughout this report, there are clear and strong arguments that sustain the next statement: the information and data presented in the analyzed documentation do not allow to give an objective and confident idea about the specific ecological, social and/or economic impacts of the present mining operations. Those arguments are the following:

- There is an enormous lack of information about ecosystems' dynamics and state;
 - The studies have covered very short periods of time, small areas and isolated parameters;
 - The parameters considered were not always specific of pollution factors (for example low productivity in agriculture is related to a large series of other factors);
 - The reports present very little or no historical references related to the management of the PRB and socioeconomic situation of the investigated areas;
 - No or insufficient information has been used and presented over:
 - permissible levels of concentration of toxic elements for human and in food;
 - extension and population characteristics of the investigated areas;
 - economic activities of the social groups concerned by pollution.
-

JICA Evaluation of Environmental Impact of Mining Sector

Area : From La Rivera up to the Puente Mendez

Centro para Desarrollo Regional

(CDR)

Wilhelm Piccola Iturralde

Executive Director

Dec. 10, '98

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1.0 INTRODUCCION

El área definida para el trabajo realizado para UNICO, la cuenca del río Tarapaya y del río Pilcomayo hasta el puente Sucre, es considerada como la más contaminada del Departamento debido a que estos ríos son drenajes de actividades minero metalúrgicas sin previsión ambiental, consecuentemente se presenta en las áreas poblacionales que tienen relación con estas cuencas, problemas sociales y ambientales que hacen insostenible en muchos casos el núcleamiento poblacional de las comunidades.

La información existente en relación al tema ambiental y la situación social en el área de estudio es limitada. A pesar de ello, existen estudios realizados por diferentes instituciones:

- Estudios que dirigen su atención a la calidad de las aguas y suelos y sus niveles de polución.
- Muy pocos estudios ambientales refieren la situación socio - ambiental de los poblados.
- Se cuenta además con diagnósticos participativos de los diferentes Municipios que reflejan la situación social y económica de las poblaciones en las márgenes de los ríos.

Nuestro trabajo se orienta hacia la cuantificación de aspectos socio - ambientales en relación a la contaminación de los ríos y sus efectos en el conjunto de la dinámica poblacional, logramos reunir la información y sistematizarla en función de este propósito.

A partir de aquello consideramos en general a la población asentada en la riveras de los ríos de estudio como en una situación crítica debido al alto deterioro de sus recursos naturales y la insostenibilidad de sus núcleos poblados.

2.0 METODOLOGIA

Para el logro de la información y datos que muestran los cuadros se tomó en cuenta básicamente la metodología participativa, logrando de esta manera anotar las percepciones de los comunarios y ajustar los datos de tal manera que se cuente con confiables aproximaciones a la realidad.

2.1 Preparación de información secundaria

Se tiene la siguiente información recopilada:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Honorable Alcaldía Municipal de Potosí, Distritación del Municipio de la primera sección de la provincia Tomas Frías, 1995
- Centro para el Desarrollo Regional (CDR), Diagnostico área urbana de Potosí, 1998
- Centro Sayarina, Diagnostico Participativo del Municipio de Tinguipaya, 1998
- Centro de Investigación y Apoyo Campesino (CIAC), Diagnostico y Planificación de Ayllus, cantón Tinguipaya, 1995
- Honorable Alcaldía de Tacobamba, Diagnostico Participativo del Municipio de Tacobamba (en elaboración), 1998
- Centro de Investigación y Apoyo Campesino (CIAC), Diagnostico Participativo del Municipio de Betanzos, 1998
- MINKA, Proyecto Prefectura del departamento, 1998
- Corporación Regional de Desarrollo de Chuquisaca, Acciones Municipales Sección Yotala, 1997
- Entrevistas con posta sanitaria de Tuero (información sobre población, salud impacto de la contaminación en áreas agrícolas y actividades pecuarias)
- MEDMIN Análisis del impacto socio económico de la contaminación del río de la rivera – Pilcomayo, 1995
- Universidad Tomás Frías Facultad de Geología, Información sobre niveles de contaminación del río Pilcomayo

A partir de la sistematización de estos documentos y estudios, se preparó información específica para cada comunidad y además de planos que permitieron ubicar ajustar y definir lo más aproximadamente posible en la etapa de campo la cuantificación de la información.

2.2 Técnicas de campo

Area Urbana:

En esta área solo se realizaron entrevistas con dirigentes vecinales a fin de ajustar datos del diagnóstico urbano con el que cuenta nuestra institución.

Area Rural

- Se aplicó boletas de entrevistas a autoridades y dirigentes comunales
- Se aplicó boletas de entrevistas colectivas abiertas
- Se realizaron entrevistas individuales aleatorias a comunarios
- Se ubicaron áreas apoyados en planos preparados conjuntamente comunarios para permitir aproximar superficies en relación a las áreas de uso agropecuario

2.3 Relación de fuentes de Información

Los datos del área urbana del Municipio de Potosí (distritos de San Juan, San Cristóbal, San Pedro, San Benito y Cantumarca) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Honorable Alcaldía Municipal de Potosí Distritación del Municipio de la primera sección de la provincia Tomas Frías, 1995
- Centro para el Desarrollo Regional (CDR), Diagnostico área urbana de Potosí, 1998
- Entrevistas con dirigentes vecinales
- Observación directa y ajuste con planos de la ciudad

Los datos del Municipio de Potosí área rural (comunidad de Jesús Valle, Molino, Arroifilla, Tambo Pampa, Miraflores y Mondragón) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Honorable Alcaldía Municipal de Potosí, Departamento área rural
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

Los datos del Municipio de Yocalla (comunidades de Cebadillas, Agua Dulce, Jaya Mayu, San Antonio, La Puerta, La Palca, Santa Lucía, Cayara, Totora «D», Totora Pampa y Yocalla) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Centro para el Desarrollo Regional, Diagnostico Participativo del Municipio de Yocalla, 1997
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

Los datos del Municipio de Tinguipaya (comunidades de Sulcari, Pallka, Juicuni, Capilla Rosario, Tacuara y Talula) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Centro Sayarína, Diagnostico Participativo del Municipio de Tinguipaya, 1998
- Centro de Investigación y Apoyo Campesino (CIAC), Diagnostico y Planificación de Ayllus, cantón Tinguipaya, 1995
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

Los datos del Municipio de Tacobamba (comunidades de Ancoma, Huerta Khasa, Kholu, Oyora, Chalama, Aczulipampa y Quebrada) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Honorable Alcaldía de Tacobamba, Diagnostico Participativo del Municipio de Tacobamba (en elaboración), 1998
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

Los datos del Municipio de Betanzos (comunidades de Km 127, San Antonio y Viña Pampa) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Centro de Investigación y Apoyo Campesino (CIAC), Diagnostico Participativo del Municipio de Betanzos, 1998
- MINKA, Proyecto Prefectura del departamento, 1998
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

Los datos del Municipio de Sucre (comunidad de Talula) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

Los datos del Municipio de Yotala (comunidades de Tasa Pampa, Tuero y Puente Mendez) se obtuvieron a partir de:

- Instituto Nacional de Estadística (INE), Censo población y viviendas de 1992
- Corporación Regional de Desarrollo de Chuquisaca, Acciones Municipales Sección Yotala, 1997
- Entrevistas con posta sanitaria de Tuero (información sobre población, salud impacto de la contaminación en áreas agrícolas y actividad pecuarias)
- Entrevistas con dirigentes comunales y comunarios
- Observación directa
- Verificación de áreas en cartas geográficas con técnicos del CDR y representantes de la comunidad

2.4 Elaboración de Información y redacción del reporte final

Una vez obtenidos todos los insumos, información secundaria y datos de campo, en el proceso de ajuste se cruza información con el fin de aproximarnos lo más posible a la realidad de las comunidades y a partir de ello iniciar la redacción del reporte final.

3.0 AREA DE ESTUDIO

3.1 Area total

El área de estudio tomó en cuenta como punto de partida la ciudad de Potosí provincia Tomás Frías y sus ríos afluentes a la cuenca del río Tarapaya. Se incluyen los ríos de Cayara, Totorá Pampa y Yocalla correspondiendo al municipio de Yocalla como afluentes de la cuenca de estudio. A partir de la cuenca del Tarapaya el área se extiende por los Municipios de Tinguipaya, Tacobamba, Betanzos, Sucre y Yotala hasta la población de Puente Sucre correspondiendo al río Pilcomayo.

La distancia aproximada está entre 145 a 150 Km de curso del río prácticamente desde la ciudad de Potosí hasta el Puente Mendez.

Comprende el estudio 5 Distritos del área urbana y 37 comunidades en el área rural. En el área urbana se tomo en cuenta 8070 familias y 34 701 habitantes y en el área rural se tomo en cuenta 1720 familias y 7396 habitantes.

A propósito de la información sobre población y cuencas hidrográficas, adjuntamos un mapa detallado sobre estos recursos, escala 1:50 000.

El cuadro muestra elementos interesantes de la dinámica poblacional, al margen de la población citadina se puede afirmar que la mayor parte de las comunidades rurales presentan migraciones definitivas y temporales cuyas causas se las puede clasificar de la siguiente manera:

- Migración debido a la proximidad de la ciudad y su influencia, minifundio y otros efectos que no están, precisamente relacionados con la contaminación de aguas y suelos o desequilibrio ambiental.
⇒ Comunidades afectadas:
Jesús Valle, Cebadillas, Agua Dulce, La Palca, Santa Lucia, Cayara, Totora «D», Totora Pampa y Yocalla.
- Migración debido a la contaminación de los ríos Tarapaya y Jaya Mayu además de la destrucción de suelos agrícolas por actividades minero metalúrgicas.
⇒ Comunidades afectadas:
Jaya Mayu, San Antonio, La Puerta, Molino, Aroifilla, Tambo Pampa, Miraflores, y Mondragón.
- Migración debido a la contaminación del río Pilcomayo y la pérdida de suelos agrícolas por el desborde del río.
⇒ Comunidades afectadas:
Sullcari, Pallka, Juicuni, Capilla Rosario, Tacuara, Talula, Ancoma, Huerta Khasa, Kholu, Oyora, Chalama y Quebrada.

Este sector es el de mayor impacto migracional, podríamos calificar como una zona crítica con relación al sostenimiento de núcleos poblacionales por cuanto están prácticamente muchos de ellos por desaparecer. Asimismo se constituye su topografía en una limitante que se suma a las causas migracionales por no existir opciones importantes para la expansión de las fronteras agrícolas.

- Migración debido a la contaminación del río y falta de cooperación en la recuperación y protección de suelos.
⇒ Comunidades afectadas:
Aczulipampa, Km127, San Antonio, Viña Pampa, Talula, Tasa Pampa, Tuero y Puente Mendez.

La realidad de este sector está muy cerca de ser crítica por su dependencia directa de la calidad de aguas del río Pilcomayo.

De lo observado se puede afirmar lo siguiente: En la medida en que se siga contaminando los ríos se seguirán poniendo en riesgo los núcleos poblacionales con el consiguiente empobrecimiento aun mayor de los comunarios y en la medida en que no exista protección o recuperación de suelos se contribuye también a los mismos efectos.

Como se muestra en el cuadro la principal actividad económica de la ciudad es el comercio que representa más del 50%, comprendiendo la venta al por mayor y menor, que para nuestro caso refleja la importancia del comercio informal en la ciudad. Seguidamente la principal actividad productiva es la minería cooperativizada, ubicada en segundo lugar de importancia dentro de la economía local, cuyas características en sus modos productivos son precarios, con inadecuada tecnología e insuficiente capacidad de almacenar stocks, lo que provoca inestabilidad respecto de las cotizaciones internacionales de los minerales; condiciones que no le permiten competir con la denominada nueva minería, que accede a tecnología de punta en virtud a altas inversiones de capital extranjero, floreciente en nuestro país.

Esta economía que podría denominarse recesiva es incapaz de absorber la creciente mano de obra proveniente de la población rural migrante, así como es incapaz de proporcionar empleo estable que ofrezca condiciones sociales y laborales deseables; luego esta población es parte inevitable del sector informal creciente.

La ocupación en el área rural está principalmente caracterizada por la dedicación hacia la agricultura y ganadería, no existen poblaciones que sobresalgan con actividades artesanales o de otro tipo que caracteriza a la comunidad.

Las actividades en relación a la metalurgia son debido a la cercanía de las mismas a plantas de ingenios son los casos de San Antonio y Aroifilla.

Las otras ocupaciones son en general los trabajos en la ciudad debido a la cercanía de las comunidades y al comercio.

Se presenta en el cuadro una relación de porcentajes que expresan la realidad de uso del agua a partir de información recogida en las propias comunidades y revisión de información secundaria.

En la ciudad si bien la totalidad de los vecinos tiene acceso al sistema de distribución de agua potable no más del 10 % usan también pozos o vertientes para ayudarse en la disponibilidad de este recurso.

En el campo 19 comunidades cuentan con sistemas de distribución de agua potable, partiendo de cajas de agua construidas de concreto, la fuente de todas ellas son vertientes cuya calidad no esta determinada, sin embargo los pobladores aceptan la calidad como buena por no tener efectos mayores en su salud.

Se observa que en las comunidades de: Jesús Valle, Cebadillas , Agua Dulce, Jaya Mayu, San Antonio, Sulcari, Pallka, Juicuni, Capilla Rosario, Tacuara, Talula, Ancoma, Huerta Khasa, Kholu, Oyora, Chalama y Quebrada, usan principalmente vertientes cuya calidad tampoco esta determinada, ellos cuentan en algunos casos con cajas de agua rústicos y otros pozas de acumulación, las molestias según los comunarios es el permanente trabajo de traslado de agua a sus viviendas que ocupa buena parte del tiempo principalmente de las mujeres y los niños.

Por otra parte se observan dos comunidades que tienen en sus alternativas de uso otros como referencia: la comunidad de San Antonio que si bien cuenta con sistema de distribución de agua potable la misma no se utiliza debido a que su fuente de suministro fue secada y su abastecimiento depende de la ciudad de Potosí vía cisternas; la comunidad de Yocalla en ciertos sectores de su poblado también utiliza cisternas para el suministro.

Otro aspecto que debe ser anotado es el uso del río Pilcomayo como fuente para consumo humano, principalmente en las comunidades de Aczulipampa, Km127, San Antonio, Viña Pampa, Talula , Tuero y Puente Méndez, las características de su uso son las siguientes: el agua de río se la filtra en las propias arenas de la playa y se consume en intermedios de las faenas agrícolas cuando no se cuenta con agua potable, según la posta sanitaria de Tuero esto ocurre con frecuencia ocasionando dolores de estómago, diarreas y otros malestares.

Se observa en el cuadro inicialmente que la mayoría de los canales son de tierra y se puede afirmar que la totalidad de los canales de distribución son también de tierra. La administración de la distribución del agua esta sobre la base de una organización conducida por Alcaldes o Jueces de agua, que son autoridades que llevan cuenta de la distribución equitativa de este recurso.

Las tierras a secano están prácticamente ubicadas en sectores elevados de los cerros o colinas y distribuidas irregularmente, la variación anual de las áreas cultivadas en muy frecuente dependiendo esta del grado de habilitación de suelos.

La cuantificación de estas fue basándonos en croquis apoyado en cartas geográficas, observación directa, entrevistas de apreciación de áreas con autoridades y comunarios y ajuste con información secundaria.

Es notorio el minifundio como problema estructural que afecta de sobre manera al área de estudio y como consecuencia de aquello se eleva el porcentaje de migración de estas comunidades.

Las parcelas se reducen significativamente especialmente aquellas beneficiadas con el riego y que son además bastante escasas.

Al problema de minifundio se suma en las áreas sujeto de estudio el problema de inhabilitación y/o degradación de suelos debido a la contaminación de aguas y suelos y desborde del río, quedando de esta manera en una situación crítica las comunidades de rivera.

El cuadro muestra también una variación en la relación de tierra a riego y a secano: las tierras altas tienen una proporción mayor de tierra a secano que de riego y las tierras bajas muestran lo contrario, advirtiéndose de esta manera la mayor dependencia de las comunidades de tierras bajas a la calidad de las aguas del río Pilcomayo.

Las áreas de pastoreo se caracterizan en esta región como de libre ramoneo es decir que las áreas de las faldas de los cerros en su totalidad están dispuestas para el ganado tanto menor como mayor. La totalidad de las mismas son las áreas que circundan a las poblaciones, de tal manera, que estas no tienen ningún otro tipo de manejo, no se encontró a lo largo del estudio ninguna área de pastoreo con riego, por tanto no existen efectos con relación a la calidad de las aguas y calidad de pasturas.

Los límites de las áreas de pastoreo son prácticamente los límites del territorio de cada comunidad, nuestro estudio tomo en cuenta el área de pastoreo del frente del cerro con relación a río y no las áreas posteriores que en muchos casos sirven también de áreas de pastoreo.

Debido a este tipo de manejo es que existe un alto grado de pérdida de cobertura vegetal que generan las erosiones de los suelos y afectan en gran medida a los cauces de los ríos.

En relación a las fuentes de provisión de la ciudad estas están ubicados en la cordillera del Kari Kari al este de la ciudad, son 6 lagunas que suministra de este líquido elemento: Chalviri, Laja Chaca, San Idelfonso, Ulistia, Lobato y San Sebastián.

La calidad de aguas según la administración de este recurso está dentro de los límites permisibles de agua potable, sin embargo se recomienda hervir o filtrar este líquido elemento para el consumo ciudadano.

Con relación a las comunidades rurales, todas ellas se proveen de vertientes cuya calidad lamentablemente no esta determinada. Sin embargo las comunidades aceptan este recurso como de relativa buena calidad.

En relación a las fuentes de riego las comunidades utilizan los ríos para este fin; los ríos contaminados son los de Jaya Mayu, Tarapaya y Pilcomayo, los restantes no muestran indicios de contaminación industrial metalúrgica ni de otro tipo.

Aisladamente existe el uso de vertientes es el caso de Mondragón que de alguna manera sobresale en el cuadro.

Los sistemas sanitarios en el área rural son escasos y los existentes no siempre funcionan regularmente por falta de mantenimiento. Son 5 comunidades que cuentan con sistemas de alcantarillado, referimos en el cuadro como sistema con descarga, de los cuales la mayor cobertura en las comunidades beneficiadas llega tan solo al 20% de la población. Se muestra claramente muy poco interés en extender estos sistemas o ni siquiera mejorarlos, debido a que actualmente existen, según los comunarios otras prioridades relacionadas con las mejoras a la productividad y generación de mejores ingresos para evitar la migración, que aumenta cada año.

Con relación a las otras alternativas, estas en su mayoría son las áreas abiertas que representan un % mayor a todas las planteadas. El área abierta, para fin del presente estudio, se entiende como espacio en las faldas de cerros y entorno de quebradas y ríos.