Outline

- Context
- Water resources monitoring program
  - Monitoring area
  - Parameters
  - Results, tables and maps
- Goals
- Methodology
- Results
- Conclusions

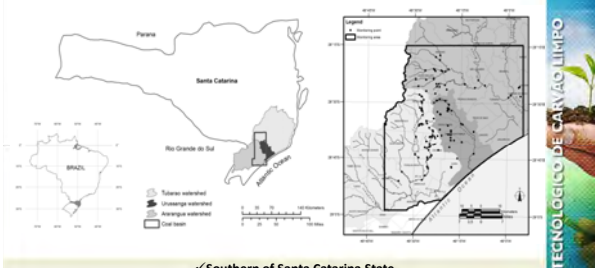
Context

- 1993: ACP | 2000: sentence | 2002 and 2006: reviews | 2007: created the technical advisory group (GTA)
- Reclamation of coal mined impacted area in Southern of Santa Catarina State, including water resources in three watersheds: Ararangua, Urussanga e Tubarao
- Conceptual Environmental Reclamation Project for the Santa Catarina Coalfield (CETEM and CANMET, 2001)
- Studies concerning characterization in the impacted watersheds, including a monitoring program
- 22 campaigns have been already performed so far - biannual

Goals

- Show an information processing methodology for an environmental data base
- GIS for a faster thematic mapping in order to represent the sites with AMD impact, including rivers
- Support the actions for the environmental reclamation project
- Provide significant information to the justice and population in general

Area of study



- ✓Southern of Santa Catarina State
- ✓195,000 ha (482 acres)
- ✓75 km N-S (47 miles)
- ✓25-30 km E-W (16 – 19 miles)

Rivers monitoring program

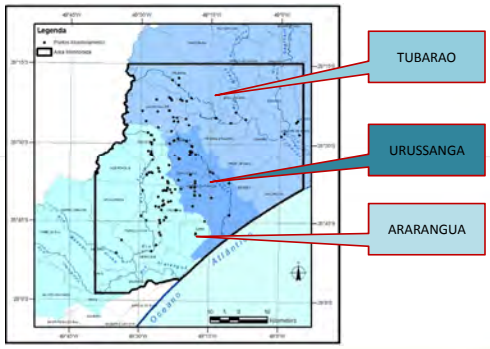
- Started in 2002 – DNPM and the SGB – CPRM agreement
- Sampling and physical-chemical analysis each 6 months
- In 2007 the monitoring program was increased and the sampling net has been accepted by the justice:
  - ✓Ararangua river = 69 points
  - ✓Urussanga river = 37 points
  - ✓Tubarao river = 34 points
  - ✓TOTAL = 140 (143 nowadays)

Monitored parameters

Parameter	Minimum
pH (23 ˚C)*	0,1
Acidity ($mg_{CaCO3}.L^{-1}$)	1
Dissolved oxygen ($mg.L^{-1}$)*	0 a 20
Conductivity ($\mu S.cm^{-1}$)**	0,001
Iron (total) ($mg.L^{-1}$)	0,02
Manganese (total) ($mg.L^{-1}$)	0,01
Aluminum (total) ($mg.L^{-1}$)	0,1
Sulphate ($mg.L^{-1}$)	0,1
Flow ($L.s^{-1}$)*	--
Temperature (˚C)*	--
Precipitation (mm/moth)	--

** Measured in the field, during the sampling*
*** Measured in the field and in laboratory*

Monitored area



Representation of results

- Tables, charts and thematic maps
- The maps produced are an important tool to decision making
- They are important to show to the justice and population how impacted by AMD are the rivers
- For example, the impact with AMD is represented by acidity concentration through maps which rivers are colored according to a range of values

Representation of results

I M P A C T E D !

Parameter	Range of values
Acidity [mg/L]	acidity < 16
	16 ≤ acidity < 120
	120 ≤ acidity < 600
	acidity ≥ 600

Methodology

2004: conversion of the spatial data to a GIS system

Data input: Monitoring results directly from the laboratory

WR basis:
- IBGE, 1:50.000 (1999) and 1:25.000 (2002)
- DNPM, 1:5.000 (2002)

Basis adjustment

Methodology

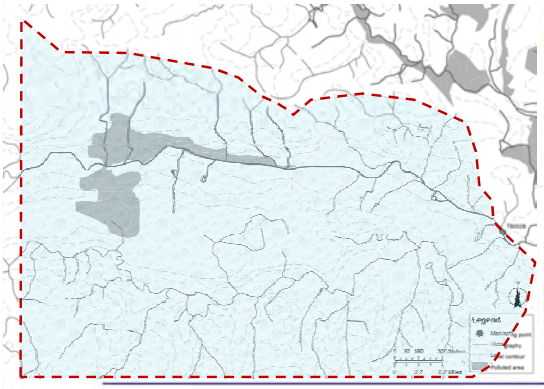
Stream tracing correction

Methodology

Delimitation of the influence area for each monitoring point – DTM

Relationship among the monitoring points and their respective river length

Delimitation of the influence area of each monitoring point



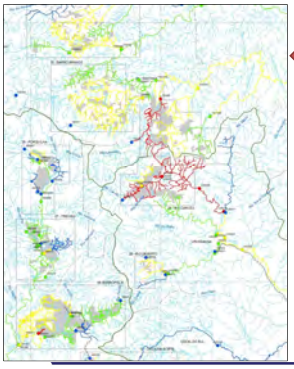
Methodology

- After the relationships of the geographical features, some procedures were performed in order to classify and quantify the data base in ArcGIS©
  - Data filtering, according to the campaign which should be analysed
  - Relationship between both hydrography attribute and monitoring results are generated by GIS system and are shown in tables
- As result it is generated a visualisation interface where data consulting is possible
- Finally, the relationship between the hydrographical feature and the monitoring results is provided

Methodology

- The parameter acidity was chosen because of its direct relationship with AMD pollution
- Each class value range is represented by one color
- The map is generated and for each stretch of river (and its respective monitoring point) a color is attributed, according its class value range

Map



acidity, 20th campaing

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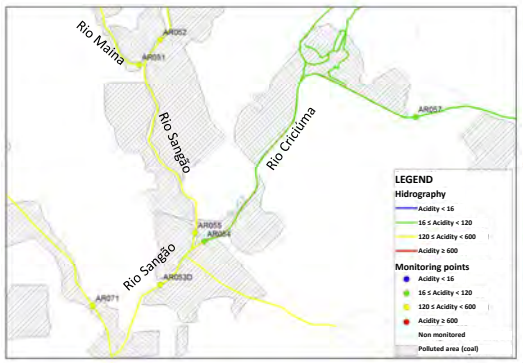

Results

Acidity classes (mg/L)	Total river length [km] Ararangua	Urussanga	Tubarao	Total	Percentage
acidity ≥ 600	52	58	21	131	0.6%
120 ≤ acidity < 600	232	50	216	498	2.5%
16 ≤ acidity < 120	179	112	147	438	2.2%
acidity < 16	44	57	124	225	1.1%
Non-monitored	5,257	1,299	12,366	18,922	93.6%
Total	**5,764**	**1,575**	**12,874**	**20,214**	**100.0%**
Total length of polluted rivers [km]*	**463**	**219**	**384**	**1,067**	**5.3%**
** (acidity > 16 mg/L)*	**8.0%**	**13.9%**	**3.0%**	**5.3%**	

Quantitative analysis – polluted rivers length

Results

Watershed	Total area [ha]	Polluted area [ha]	%
Ararangua	302.540	3.638	1,20
Tubarao	596.023	1.942	0,33
Urussanga	70.890	762	1,07
Total	**969.453**	**6.342**	**0,65**

Quantitative analysis – polluted areas (coal mining)

Results

Watershed	Coal pollution surface area	river length
Ararangua	1.2%	8.0%
Urussanga	1.1%	13.9%
Tubarao	0.3%	3.0%
Total	**0.7%**	**5.3%**

Integrated analysis

Conclusions

i. Although Urussanga watershed be the smallest monitored area in this reclamation program (709 km²) it is proportionally the most AMD polluted one (14% of its total rivers length)

ii. In another hand, Tubarao watershed, that has 5,960 km², shows only 3% of its total rivers length polluted

iii. Ararangua (3,025 km²) has 8% of its total rivers length polluted

iv. Roughly 5% (1,067 km) is polluted by AMD in the three watersheds

v. Besides acidity, any other parameter can be represented through thematic maps

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Projeto de Recuperação Ambiental

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SATC