

Case study of impacts of DRENURBS Project on Bonsucesso Creek

Étude de cas des impacts du projet DRENURBS dans le cours d'eau Bonsucesso

By Janaína A. Evangelista¹, and Professors Márcio B. Baptista², Priscilla M. Moura³ and Sylvie Barraud⁴

^{1,2} and ³ – Department of Hydraulic and Water Resource Engineering of the Federal University of Minas Gerais, Brazil ⁴ – Laboratoire DEEP- Insa de Lyon

Email Addresses:

janainaae@ig.com.br; marcio.baptista@ehr.ufmg.br;
priscilla.moura@ehr.ufmg.br; sylvie.barraud@insa-lyon.fr

RÉSUMÉ

La mairie de la ville de Belo Horizonte, de l'état de Minas Gerais, MG, Brésil, a mis en œuvre un programme de développement destiné à promouvoir l'intégration sociale et environnementale des cours d'eau qui sont restés dans leurs lits naturels. Ce programme englobe des actions intégrées pour traiter le fond des vallées, améliorer le système routier, les eaux usées et la collecte des résidus solides, le contrôle des inondations, la réinstallation ou le déménagement de familles vivant en zones à risque, et l'installation d'équipements pour les loisirs. Cependant, les méthodes adoptées et la réalisation des objectifs ont été remis en question. Cet article présente une étude d'un bassin versant inclus dans le programme, le bassin versant de Bonsucesso Creek, pour laquelle ont été évalués les pressions et les impacts sur les systèmes sociaux et environnementaux, et les actions proposées. Les solutions en matière d'assainissement, hydraulique, social et environnement, ont été énoncées dans les projets mais elles ne sont pas pleinement mises en œuvre. Par conséquent, les méthodes conventionnelles adoptées pour contrôler les inondations, stabiliser et prévenir l'érosion de la rivière, n'ont pas réglé les problèmes sociaux et environnementaux tels que ceux liés à la qualité de l'eau et la santé publique.

ABSTRACT

The city of Belo Horizonte, state of Minas Gerais, MG, Brazil, has implemented a developing program meant to promote a wider social and environmental integration of watercourses that have remained flowing in their natural riverbeds. It encompasses integrated actions to treat valley bottoms, improve road system, wastewater and solid residue collection, flooding control, resettling or removal families from risky areas, and installation of equipment for recreation and pastime. However, the methods adopted and their resulting attainments have been called into question. This paper presents a case study of a watershed included in the program, the watershed of Bonsucesso Creek, which has evaluated the pressures and impacts on the social and environmental systems, and the proposed actions. Sanitation, hydraulic, social and environmental solutions, although they've been planned in the projects, have not been fully implemented. As a result, the conventional methods adopted to control floods, stabilize and prevent riverside erosion have not solved social and environmental issues such as the ones related to water quality and public health.

KEYWORDS

Bonsucesso Creek Watershed, interventions in watercourses, Impact evaluation, DPSIR framework

1 INTRODUCTION

DRENURBS is the name of a program implemented by the City of Belo Horizonte, MG, in the Southeast region of Brazil that's aimed to prioritize the use of alternative treatment solutions while taking into account higher social and environmental integration levels regarding the watercourses in the municipality. Such type of solution is applicable to watercourses that, even though they've been already somewhat degraded, the most part of their natural banks have remained natural. This is a case study of one of the watersheds included in the DRENURBS program, Bonsucesso basin Creek. The objective of this paper is to estimate the intervention choices made by the city and the impact of such interventions as a large part of the project has not yet been implemented. Almost the whole watercourse was flowing in their natural bank with some areas still featuring riparian forests, residential and commercial areas, and as well industrial plants. Studies and projects carried out by the city of Belo Horizonte were used to evaluate the main problems of the river basin such as floods, erosive processes, poor water quality due to the discharges of untreated wastewater and urban solid wastes. DPSIR framework developed by European Environmental Agency (EEA) that was used to evaluate the pressures and impacts existing before the interventions and after the changes that have been implemented in the water course.

2 DPSIR FRAMEWORK

UNEP (2009) proposed the used of DPSIR framework to evaluate the interrelation between urban development and environment meant to help plan public policies. This framework sets the causality relations between economic and human (driving force) activities that pressure the environment, and cause environmental changes that impact the ecosystems, public health, and other affairs. The answers corresponding to individual and collective actions are the instruments used to mitigate or prevent such impacts that may be public policies, economic and administrative acts such as regulations, tax incentives, or physical interventions.

3 BASIN CHARACTERIZATION

Bonsucesso creek basin comprises two main watercourses, namely Bonsucesso and Olhos D'água. The basin has an area of 11.92 km² and a Thalweg extension of 22.6 km. This watercourse is a right side tributary of Arrudas River located in the South of the municipality of Belo Horizonte (Figure 1). The analyses based on the studies on Sanitation and Environmental Diagnosis (Belo Horizonte, 2002), by the basic and executive projects of DRENUSBS Program (Belo Horizonte, 2009), and field surveys. Such surveys were carried out on August 3, 2011, after the construction a contention reservoirs and before interventions on the river channels, and on November 12, 2011, after finishing the most part of those interventions. Based on the diagnosis performed by the city of Belo Horizonte for planning DRENURBS projects, it was possible to detect the driving forces, pressures, state and impacts shown in the Figure 2. The action indicated are the ones performed by the city according to the basic and executive projects.

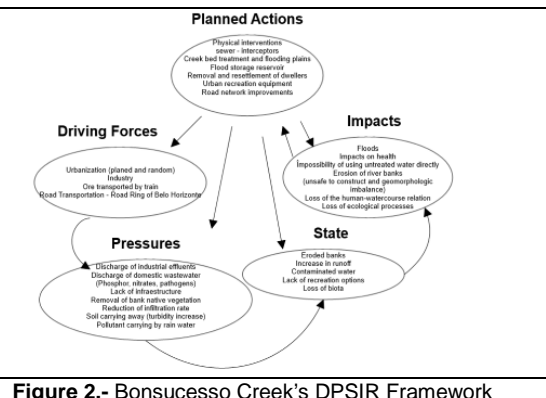
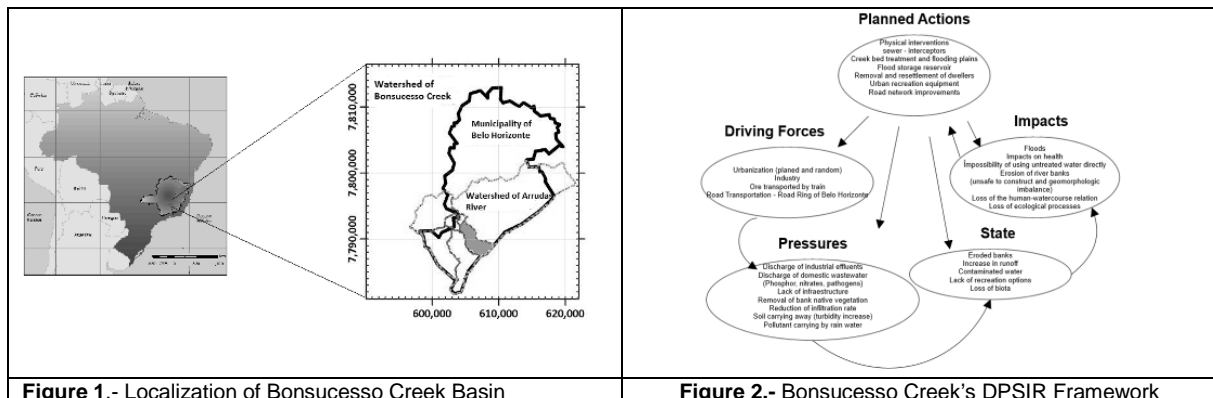
3.1 Driving forces

The urbanization that was partially guided by the soil use and occupation law, however there was a significant presence of irregular settlements featuring poor infrastructure. The road system was poor, and there were areas not attended by the solid waste collection, dwellings with no sewage systems in both, in the irregularly and formally occupied areas. There's some commercial activities in the residential areas, and even more expressive near the street named Ursula Paulino. In the basin there are many **industrial plants** such as metallurgical plants and food processing plants. There are **transportation roads** such as Belo Horizonte Road Ring, BR-262 and BR-040 roads, and also a **railway used for the transportation of ores**. However, the basin has preserved green areas such the ones located around the areas of the hospitals named Bezerra de Menezes e Julia Kubitschek, and CIA Siderurgica Mannesmann.

3.2 Pressures

Discharge of sewers into the creeks – The sewage system existing by the time these projects were being designed comprised only sewage collecting systems, interceptors. The WTP of Olhos D'água would receive the effluents from the neighborhoods named Pilar and Olhos D'água were not yet in operation. The collecting systems of Bonsucesso creek basin attended about 65% of the whole population of the basin, and the existing interceptors were insufficient in extension to receive the existing sewage system. Such a deficiency allowed many sewage system to drain over the whole

basin. According to survey and diagnosis performed the existing sewage collecting system as 65.1 km long, while the extension of the streets with no sewage system was 3.4 km long, and there was yet an area of 143.9ha corresponding to villages and settlements where there was no basis installations of sewage systems.



Discharge of domestic solid waste into the creeks – There were residential garbage curbside collection services in the formally urbanized localities. Nevertheless, in the villages and settlements, narrow driveways did not allow garbage pickup trucks to enter to collect residential solid waste, and the dwellers were asked to take their garbage to the near streets where the collection was done, however some dwellers stated that some were throwing their garbage into the creek banks instead. Formal settlements were attended by weekly street sweeping service, while among the informal settlements only the neighborhoods of Bonsucesso, Novo das Industrias and Betania were attended by this service.

Deficiency of Solid waste road transportation – There was interconnection-related problems among the basin neighborhoods, disarticulated road system due to the random occupation, localization of the road ring that's lengthwise parallelized to the creek, and the railroad that divided it into two neighborhoods. Besides that, about 5% of the roads were not paved, while 15% were not registered, or had not been constructed, and therefore, nearly 20% of the roads directly contributed to solid waste discharge into the creek (Belo Horizonte, 2009).

3.3 State

The degradation showed in the studies and confirmed by during an inspection visited done in August 3, 2011, indicated the existence of further erosion processes in some places (Figure 3b); and place were solid waste had been disposed (Figure 3c); contamination of clean water by wastewater that was being discharged untreated into the watercourses in many places, and solid waste disposed alongside the banks (Figure 3a); many houses with no driveway for garbage trucks; and the lack of recreation public areas.

3.4 Impacts

Drinking water supply data of Belo Horizonte in 2011 indicated 100% of population coverage, the sewage collect coverage was 96%, but only 69% of collected sewage was treated (Belo Horizonte, 2013). Due to the deterioration of water quality of Bonsucesso creek, its impact on the community health was evaluated based on the database of Ministry of Health of Brazil related to the number of hospitalizations due to acute diarrhea, in which 36 cases were reported between June 2000 to May 2001 (Belo Horizonte, 2009). The scope of health care services were classified according to the percentage of the populated exposed to high risk level so that the social and sanitation conditions of basin and close to health care centers were poor, especially in the village CEMIG where 100% of the population was found to be threatened, 69% in the villages of Pilar and Olhos D'água, and 34% in the neighborhood named Novo das Indústrias. The draining systems have been found to be deficient in micro drainage capacity, which caused floods due to the limitations of the road drain inflow capacity and hydraulic structures that in most part have flood recurrence intervals of two years, which explained annual flood occurrences in the basin. Four critical points were found that were chosen as the most suited solution for contention reservoir basin construction. Such technical remarks were backed by a survey with the dwellers who indicated the community problems and demands. The main remarks were the discharge of wastewater and disposal of solid waste into the creeks, poor health care infrastructure, very poor local street network, and sanitation and recreation infrastructures.



a) Wastewater and solid waste



b) Eroded bank



c) Sedimentation

Figure 3: – Photos of Bonsucesso Creek

3.5 Responses or Actions

The project works comprised valley bottom treatment, contention of riverbanks, complement macro and micro drainage systems, implementation of flood contention reservoirs and storage areas, wastewater outflowing systems with sewer interceptors and complementation of the wastewater collection networks, treatment of areas exposed to erosion, implementation of a road/street network and areas of social use, disappropriating actions, removal and resettling of dwellers.

3.5.1 Planned actions

Creek bed – the project planned lining the creek bed with bedded rockfill materials placed throughout its extension, except Olhos D'água Creek and one of the arms of the three headwaters of Bonsucesso creek. Thus, the only solution was to make artificial intervention to a section of the channel including the upstream sections where the erosion processes were not so significant. Although the bedded rockfill would allow the water to flow between the creek bed and the water table, it's still impactful and restricts the creek geomorphological dynamic.

Flood control – Two flood storage reservoirs were planned along with the improvement of the surrounding road network, and the installation of spare-time activity and recreation equipment.

Sanitary Sewer – Three action lines were planned, one included in DRENURBS project that corresponded to the formal occupation of the area, which was not included in COPASA projects (Sanitation company of the state of Minas Gerais), and other in areas of informal villages and settlements under responsibility of URBEL (Urbanization Company of Belo Horizonte), and actions planned by COPASA. The problem related to the lack of wastewater treatment would be solved by constructing interceptors that would take the sewerage to the Arrudas and Olhos D'água WTPs that was being implemented. At this point, it's worth pointing out that areas with more serious problems regarding sanitary sewer were the villages and settlements that, therefore, would not be included in this program, the informal villages and settlements.

Road Network – road network improvements were planned around the dams and other places to better integrate the neighborhoods, and provide paved driveways to allow for the traffic of garbage trucks. The construction of social areas and gardens around the dam, squares and alongside watercourse were planned with a surrounding lane for protection and maintenance.

Solid waste – the road network improvements and the implementation of environmental education programs would be the main solid waste management improvements.

3.5.2 Actions carried out

In the visit made on August 3, 2011, one of the contention reservoir had been constructed, however the recreation equipment planned in the project had not been installed, and the surrounding area was fenced, i.e., there was no place available to be used by the population. Such situation remained unchanged until the visit made on November 12, 2015 (Figure 4a.). The bedded rockfill planned solution was implemented only in a small upstream section with the existing concrete canalization. The designed solution was changed to a trapezoidal channel in mattress shaped gabions (Figure 4c). The floods did not happen after that work shown in the Figures 4b and 4c. The problems related to eroding processes were solved, however with the loss of fluvial geomorphology dynamic processes caused by the stiff contention of the banks. Another important aspect to be pointed out is the strong impact on the landscape that was not accomplished one of the preconditions of the program, which was the landscape architectural integration. In no section visited on November 12, 2015, there was recreation equipment installed. Changes in the road network were restricted to the dam area, and therefore, according to the dwellers and community leaders, the driveways for the access of garbage trucks had not been constructed.



Figure 4: – Bonsucesso Creek after the intervention

The water quality monitoring report of the program of March 2012 (Belo Horizonte, 2012), which evaluated the basin water from April 2008 to February 2012, i.e., before and after the intervention works, confirmed that the water contamination by wastewater was not solved according to the qualitative field evaluation. Three monitoring points was chosen, i.e., Olhos D'água Creek (E₁) and Bonsucesso Creek (E₂, E₃ and E₄). BOD (Biochemical Oxygen Demand) values at the four monitoring points were all the time above the value required by the local law, which's up to 5mg/l, except in two of the evaluations at E₁. The mg/l values of the samples collected in February 2012 were E₁ = 3.3, E₂ = 64.2, E₃ = 26 and E₄ = 21.1. The Water Quality Index (WQI) evaluated the quality according to the following rating: excellent, good, average, bad, and very bad. Except Olhos D'água Creek, E₁, which's mostly in a preserved green area, the water quality remained the same or declined at all the other points, and was categorized as bad or very bad.

4 CONCLUSIONS

The evaluation results allow for some reflections regarding the understanding of the concept of less impacting and more socially and environmentally integrated works, and the importance of integrated actions related to urban watercourses. Based on the studies and projects of the program, it's clear that the approach of the city of Belo Horizonte to any solution other than the concrete channel was considered to be an alternative solution to “integrate water resources to the urban landscapes.” The solutions chosen, the bedded rockfill and the gabion are more impacting, and make the transversal sections more artificial. The gabion solution for headwater sections where the banks have not been populated and are stable allowed for the adoption of milder techniques such as bioengineering that's much less costly than a conventional engineering works. They may be also associated with vegetation recovery alongside the banks and the construction of linear parks, which are more beneficial to the social and environmental integration and the reduction of maintenance costs that are much lower than costs of repairing and recuperating the gabion sections and concrete recovery work. Another essential aspect is the need of implementing integrate actions to solve the problem in many dimensions involved. In such a case, the city of Belo Horizonte made a plan to partially meet such requirements by articulating interventions to road network infrastructure, sanitation, and hydrologic and social interventions. Nevertheless, the implementation was done according to the conventional solution based on flood controlling and bank stabilization. In that case, the public health was not prioritized, and the untreated wastewater discharge into the watercourses being studied has not been a priority in the current fluvial intervention projects.

5 ACKNOWLEDGEMENTS

We thank CAPES, CNPq, FAPEMIG and the Prefecture of Belo Horizonte.

REFERENCES

- BELO HORIZONTE. Prefeitura Municipal. (2013). *Plano Municipal de Saneamento 2012-2015. Volumes I/II.*
- BELO HORIZONTE. SUDECAP. (2012). *DRENURBS - Relatório do monitoramento da qualidade das águas, Sub-Bacia do Córrego Bonsucesso - Relatório consolidado marco zero e fase de obras - Abril/08 a Fevereiro/12.* Belo Horizonte.
- _____. (2009). *Programa DRENURBS - Bacia do Córrego Bonsucesso - Projeto Executivo, Memorial Descritivo e projetos.* Belo Horizonte.
- _____. (2009). *DRENURBS-BH, Programa de Recuperação Ambiental e Saneamento dos Fundos de Vale dos Córregos em Leito Natural - Diagnóstico sanitário e ambiental bacia do Córrego Bonsucesso – 4110400 - lote 1 - volume 1 – Tomo I.* Belo Horizonte.
- [UNEP] United Nations Environment Programme. (2009). *Methodology for the preparation of GeoCities reports – Training Manual Version 3. Regional Office for Latin America and the Caribbean Copyright, United Nations Environment Programme and Consorcio Parceria 21.* Panama.