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RESETTLEMENT OF FORCIBLY DISPLACED PEOPLE: CASE STUDY OF BENTO RODRIGUES FOLLOWING THE ENVIRONMENTAL DISASTER OF THE FUNDÃO TAILINGS DAM FAILURE

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Abstract

This article aims to study the still ongoing process of resettlement of the village of Bento Rodrigues, in Mariana, Brazil, from the Fundão tailings dam rupture moment, through the temporary resettlement solution proposed in the city of Mariana, and finally the approval of the new settlement's urban design in 2018, more than two years after the disaster. In 2022, more than six years after the disaster, the community has not been resettled yet. Through varied literature research, we will discuss the resettlement process of this community by analyzing the community's participation in it, the urban design process and two of the urban design solutions presented for the new settlement. Through the study of this resettlement process, it will be possible to identify some key factors that have influenced it and that can significantly influence the success or lack thereof of whole community resettlement operations of forcibly displaced people.

Streszczenie

Niniejszy artykuł ma na celu zbadanie wciąż trwającego procesu przesiedlenia wioski Bento Rodrigues, w Marianie, w Brazylii, od momentu pęknięcia tamy wód pokopalnianych Fundão, poprzez tymczasowe rozwiązanie przesiedleńcze zaproponowane w mieście Mariana, aż do zatwierdzenia projektu urbanistycznego nowej osady w 2018 roku, ponad dwa lata po katastrofie. W 2022 roku, ponad sześć lat po katastrofie, społeczność nie została jeszcze przesiedlona. Poprzez pogłębione badania literaturowe omówimy proces przesiedlenia tej społeczności, analizując udział w nim społeczności, proces projektowania urbanistycznego oraz dwa z rozwiązań urbanistycznych zaproponowanych dla nowej osady. Dzięki badaniu procesu przesiedlenia możliwe będzie zidentyfikowanie pewnych kluczowych czynników, które miały na niego wpływ i które mogą znacząco wpłynąć na sukces lub jego brak w przypadku operacji przesiedlania całej społeczności przymusowo wysiedlonych osób.

Keywords: Fundão tailings dam; forced displacement; Bento Rodrigues; Brazil

Słowa kluczowe: tama wód pokopalnianych Fundão; przymusowe przesiedlenie; Bento Rodrigues; Brazylia

INTRODUCTION

The failure of the Fundão tailings dam located near the city of Mariana, in Brazil, on November 5, 2015, resulted in what was classified at the time as the country's biggest environmental disaster. According to the Brazilian Institute of Environment and Renew-

able Natural Resources [Ibama, 2015a], the tailings that flowed from the dam traveled 663.2 km along rivers in the Brazilian states of Minas Gerais and Espírito Santo until they reached the Atlantic Ocean. On this route, the tailings flow took the lives of 19 people, destroyed villages, and contaminated the land and waters of part

of the Doce River watershed, affecting the fauna, flora, and the lives of thousands of people whose livelihood depended on these natural resources [Ibama, 2015a].

Bento Rodrigues, a rural sub-district of Mariana, located approximately 4 km from the dam, was the first settlement hit by the tailings wave. With a population of approximately 600 people, the population of Bento had to flee the settlement or reach higher placed areas to save themselves. Subsequently, the community was provisionally relocated in the city of Mariana. Most of the population still lives in Mariana, waiting for the reconstruction and resettlement of Bento Rodrigues in a new location, since the destruction of its buildings and the contamination of soil and water by the tailings made the old Bento Rodrigues settlement uninhabitable.

This article aims to study the resettlement process of the Bento Rodrigues community as a forcibly displaced community. The relevance of this theme fits into the current context and future predictions that link climate change to the greater occurrence of tragic environmental events that will force the displacement of more people and communities around the world, especially in the global south. It is therefore necessary to discuss ways of dealing with these displacements from the perspective of urban planning, architecture, and the adaptability of human settlements.

Therefore, this article will discuss the practices, proposed solutions and results obtained so far for the resettlement of the Bento Rodrigues community. The

process of rebuilding the community and resettling the population will be analyzed based on the decision-making and problem-solving processes implemented, the resettlement options offered, the urban planning and design process of the new settlement, the support offered to the displaced people, the community participation in the rebuilding and resettlement process, and the current status of resettlement of those affected.

1. METHODS

This article uses the individual case study method to present the process of resettlement of forcibly displaced people and its subsequent phases. A study of the resettlement process was conducted on the example of the village of Bento Rodrigues. The factor type for the described process was the environmental disaster. An important aspect of the research was to trace all phases from the moment of the catastrophe to the present day. The article's purpose was to describe the process of resettlement of forcibly displaced people. The conclusions formulated about resettlement processes may be important in predicting analogous processes in the forecasted climate migration.

The basic research material was administrative documentation, reports prepared for the needs of public institutions and contemporary scientific literature describing various aspects of the catastrophe. The publication uses informational materials of institutions, foundations, and associations involved in the resettlement

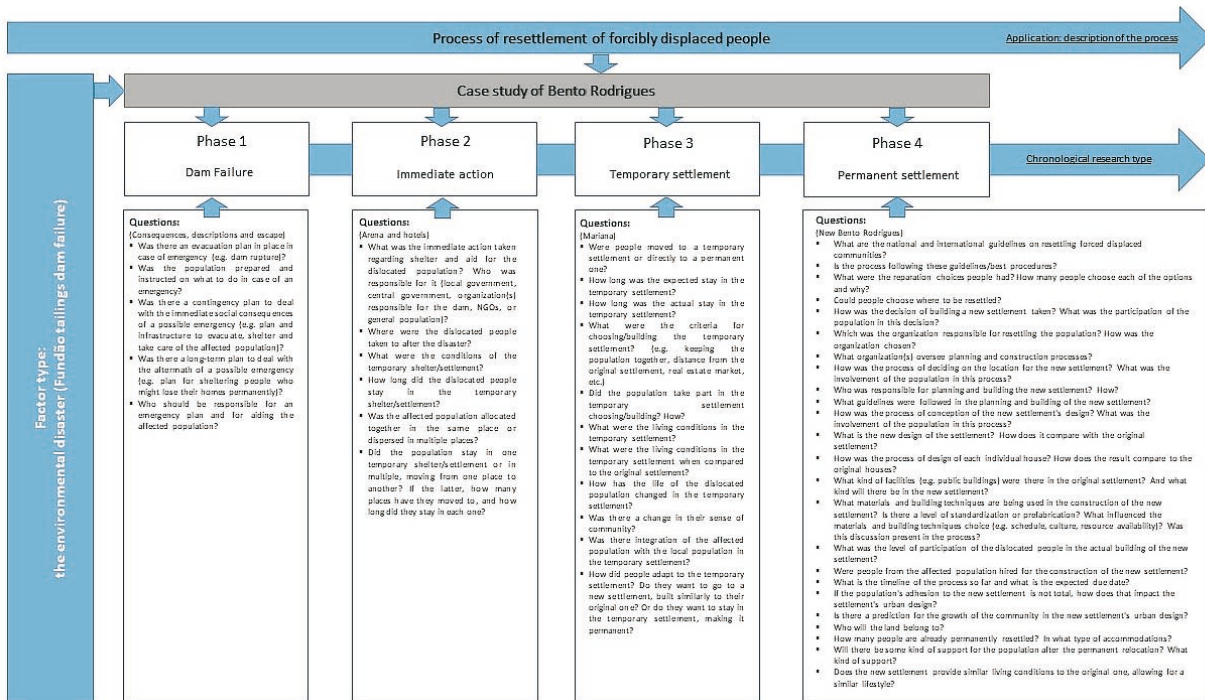


Fig. 1. Flow chart presenting the entire methodology and the role of questions in the research process of the Bento Rodrigues case study; source: prepared by the authors

ment process, verifying data from these sources. Additional materials include versions of plans made for the new housing estate and analyses of the topography of the new housing estate by other authors. The materials were supplemented by information from the media.

pouring into the Atlantic Ocean on November 21, 2015 [Ibama, 2015a]. The mud affected 40 municipalities, 36 in the state of Minas Gerais and 4 in the state of Espírito Santo [Ibama, 2015b], causing 19 fatalities and various social, environmental, and economic damages. These damages include among others: the destruction of buildings and infrastructures, displacement of people, interruption of the activity of hydroelectric plants, de-

2. FUNDÃO DAM FAILURE AND ITS CONSEQUENCES

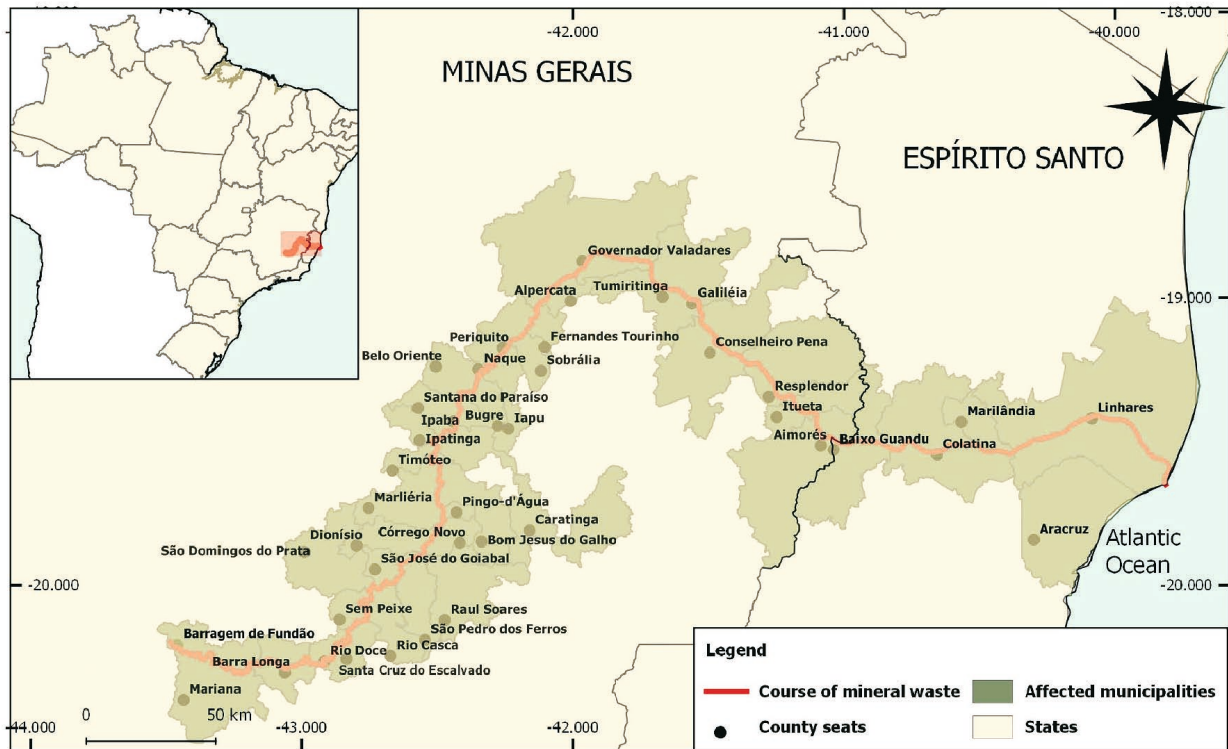


Fig. 2. Course of the ore tailings after the dam rupture in Mariana (Brazil). Affected municipalities in the states of Minas Gerais and Espírito Santo; source: Max Vasconcelos [Zhou et al., 2017]

The Fundão tailings dam, owned by Samarco Mineração S.A. (a joint venture between Vale S.A. and BHP Billiton Brasil Ltda.) and located in the municipality of Mariana/MG, ruptured in the afternoon of November 5, 2015, dumping 34 million m³ of iron ore tailings into the environment [Ibama, 2015a]. The tailings flow from the dam, which had 56.4 million m³ of tailings originally, continued after the disaster, reaching a total of 43.8 million m³ spilled, a figure that remained stable between July and November 2016, one year after the disaster [Fundação Renova, 2016; Fundação Renova, 2017]. According to a study carried out by Carmo *et al.* (2017) on the failure of ore dams between 1915 and 2016, this can be considered the biggest technological disaster in the world due to the quantity of material released and the extent of the affected environment.

The ore tailings flow, which became known as a “mud wave” or “mud sea”, reached a total of 663.2 km of water courses in the Doce River watershed,

destruction of agricultural areas and pastures, interruption of water supply and fishing activity, destruction of protected areas of the Atlantic Forest, silting of rivers, death of aquatic biodiversity and terrestrial fauna, loss and fragmentation of habitats [Ibama, 2015a]. The tailings course and the affected municipalities are shown below in Figure 2.

The mud wave overflowed the riverbed in the first 77 km of its course, affecting public and private buildings and infrastructures in a degressive manner [Ibama, 2015a]. In this section, 10 villages belonging to 5 municipalities (Mariana, Barra Longa, Ponte Nova, Santa Cruz do Escalvado, and Rio Doce) were directly hit by the mud [Carmo *et al.*, 2017]. Three of these villages are part of a resettlement program established in an agreement made between many governmental agencies and the companies Samarco, Vale and BHP: the villages of Bento Rodrigues and Paracatu de Baixo, in Mariana, and Gesteira, in Barra Longa (*Termo de Transação e de Ajustamento de Conduta* [TTAC], 2016).

Bento Rodrigues was the village located closest to the dam and the one that suffered the most direct damage caused by the rupture [Carmo *et al.*, 2017], with 207 out of its 251 mapped buildings, that is 82%, affected by the mud [Ibama, 2015b]. It was also the village with the biggest number of impacted families covered by the resettlement program, with 289 families in 2020, followed by Paracatu de Baixo with 145 families and Gesteira with 37. There were also families outside of these villages that were covered by the resettlement program, e.g., rural communities in the municipalities of Mariana and Barra Longa [Ramboll, n.d.b].

In this article we will discuss the process of resettlement of these families, focusing on the village of Bento Rodrigues. First, the emergency actions taken regarding the evacuation and sheltering of the dislocated people will be presented. Then, the temporary housing arrangements made for the families – in which most of them still live to this day – will be discussed. Next, the resettlement program established between the companies responsible for the dam and the government will be briefly described. Afterwards, we will focus on the permanent resettlement of Bento Rodrigues, describing the process and community participation up until the approval of the village's urban design, in February 2018. Finally, the information and the processes presented will be discussed, followed by conclusions that may contribute to the literature on the resettlement of displaced communities.

3. EMERGENCY ACTIONS: EVACUATION AND SHELTER

When the Fundão tailings dam ruptured, there were no sound alarm systems in place to warn the population from nearby villages about the disaster [PoEMAS, 2015]. The official warning, according to one of Samarco's representatives, was made by phone call to a few residents, not specifying how many people were contacted or the content of the calls. Along with the residents, the company warned the Civil Defense Agency and Mariana's City Hall [Veja, 06 November 2015b].

The credit for warning the population about the disaster often goes to two outsourced employees from Samarco that decided to go down to Bento Rodrigues and drive through its streets alerting the people. One drove through the village by truck, carrying dozens of people in its bucket and driving them away from the mud wave [Veja, 06 November 2015a; Vital, n.d.]. The other, who was also a resident of the village, drove through its streets on her motorcycle telling people to

escape to higher situated places [Passarinho, 5 February 2019; Vital, n.d.]. Nonetheless, not every resident was informed about the disaster [Vital, n.d.].

The account of Bento Rodrigues' population varies greatly, ranging from around 400 people to around 600 – with 600 being the most used figure [Samarco, n.d.a; IBGE, 2015 *apud* PoEMAS, 2015; Minas Gerais, 2015 *apud* Souza & Paaz, 2019; G1, 5 November 2015]. At least 120 people spent the night of the disaster in the Church of Nossa Senhora das Mercês [Estadão Conteúdo, 06 November 2015], located in a higher area of the village [Samarco, n.d.a]. According to Estadão Conteúdo [06 November 2015], they were rescued in the morning of the next day and brought to Arena Mariana, the sports center of the city of Mariana, located about 25 km away from Bento, where other 150 people who were able to flee the village had spent the night.

4. TEMPORARY SETTLEMENT

Arena Mariana served as shelter for the dislocated people from Bento Rodrigues and other villages hit by the mud or in danger of being flooded. Also, it became the distribution center for the donations received, such as food, clothes, shoes, mattresses, bed linen and personal hygiene items [G1, n.d.]. As can be seen in Figure 2, the court of the sports center was furnished with mattresses, while the donations were sorted by volunteers in the adjacent room.

People started being transferred from the sports center to hotels and inns after the intervention of the Public Ministry, who considered that Arena Mariana's space (Figure 3) was not adequate to receive the dislocated families [PoEMAS, 2015]. According to Samarco Mineração [Mineração, 23 February 2016], people started being transferred within 24 hours of the disaster, while according to the National Human Rights Council [CNDH, 2017] the transferring process started three days following the disaster.

Each dislocated family seems to have been placed in one room in the hotels and inns they were provided with (Figure 4). According to Estronioli [3 December 2015], one of the complaints about this arrangement was the lack of privacy, citing as an example a room that was furnished with twelve single beds. There were also examples of smaller rooms, such as one with three single beds [Estronioli, 3 December 2015], and some exceptional cases, where the family from the village of Paracatu de Baixo was settled in a house (with almost no furniture or home appliances) due to the big size of the family – one mother and ten children [Camargos, 28 November 2015].



Fig. 3. Sports center Arena Mariana as first shelter for the dislocated people from Bento Rodrigues. Main court furnished with mattresses to receive the dislocated people and donation sorting room; sources: Gustavo Pimentel [G1, n.d.] and Lucas Prates/Hoje em Dia/Estadão Conteúdo [G1, 5 November 2015]



Fig. 4. Each dislocated family was placed in one room in the hotels and inns they were provided with. The example above shows one of the rooms used as temporary shelter for the dislocated people in Hotel Providência. Source: Elisa Estronioli/MAB (Estronioli, 3 December 2015)



Fig. 5. An image presented by Samarco in a news piece about the relocation of the dislocated families to temporary houses. The temporary houses were provided to the families with furniture, home appliances, domestic utensils, trousseau, food, cleaning products, personal hygiene products, and drinking water; source: Samarco (28 November 2015)

The families received packed meals for lunch and dinner during their temporary stay at the hotels and inns [Estronioli, 3 December 2015]. In a promotional video made by Samarco Mineração [Mineração, 23 February 2016] about one of the hotels that received the dislocated families, Hotel Providência, it is stated that the families were provided with four meals: breakfast, lunch, afternoon snack, and dinner. The dislocated people also had to respect established hours to return if they wanted to leave the hotels during the day, and those located in areas further from the center did not receive transportation vouch-

ers [*Movimento dos Atingidos por Barragens [MAB]*, 25 November 2015].

Later, people were transferred from the hotels and inns to temporary houses rented by Samarco. According to CNDH (2017), each family was able to choose between three houses presented by the company. For the selection of the houses, factors such as proximity to relatives, house location and number of people per household were taken into consideration [Samarco, 28 November 2015].

Initially, Samarco presented a plan that contemplated the transferring of 25 families to temporary

homes per week, which meant that all families would be settled by February 2016 [Samarco, 27 November 2015]. However, in a meeting between the dislocated communities and the Public Ministry in the end of November, the communities expressed their desire of spending Christmas in their new home, and not in hotels [Aguiar, 28 November 2015]. The dislocated people also organized a petition, with over 200 signatures, asking for the deadline of the relocation of families to be on December 20. On December 1, Samarco presented to the commission elected by the communities affected by the dam rupture a new plan predicting the transferring of 50 families per week [MAB, 02 December 2015].

The Public Ministry also acted in defense of the relocation of the families before Christmas with this being one of the points of a Conduct Adjustment Term (TAC) proposed to Samarco. When Samarco did not sign the term, the Public Ministry filed a public civil action requesting, among other points, the payment of a fine for each family not relocated by the company until Christmas [G1, 10 December 2015].

According to Samarco [Samarco, 24 December 2015], 351 families out of the 355 impacted by the dam rupture in the cities of Mariana and Barra Longa were relocated in houses rented by the company or in relatives' houses by December 24, 2015. This meant that 908 people were relocated in time to spend Christmas at a new home. The four families, numbering eight people, that remained in hotels did so by their own choice [Samarco, 24 December 2015].

The temporary houses were provided to the families with furniture, home appliances, domestic utensils, trousseau, food, cleaning products, personal hygiene products, and drinking water (Figure 5). The company stated that the transfer of families would follow the criteria defined in meetings between the company, representatives elected by the dislocated people within the communities, the Public Ministry, and other relevant organizations [Samarco, 27 November 2015; Samarco, 24 December 2015].

One of the criteria defined was that families with elderly people (65+ years old), children, pregnant women, newborns, disabled people, and people dependent on medical care would be given priority for leaving the hotels and inns, and be transferred to temporary houses [Samarco, 27 November 2015]. According to MAB [25 November 2015], the dislocated people made allegations that the transferring of the families did not follow the criteria defined.

According to a report issued in 2019 by Ramboll (n.d.a), there was a total of 330 temporary houses rented for the dislocated families in the cities of Mariana and Barra Longa, while other 119 families received financial compensation or were located in hotels. Ramboll inspected 184 temporary houses in the city of Mariana in 2018 and only 47.8% were considered adequate. In 2020, this figure rose to only 50.5% [Ramboll, n.d.b], and in 2021 to 51.6% [Ramboll, 2021a]. Detailed data on the temporary houses' adequacy are shown in Table 1.

The map presented in Figure 6 shows the location of the temporary houses visited by Ramboll in the city of Mariana and information on their risk assessment and need for relocation. From this image we can verify that the dislocated families were settled in a dispersed manner in the city. This arrangement could be explained, among other reasons, by the availability of houses in the market at the time of the rental operation.

According to Barreto, Rosa & Mayorga [2020], the physical distance among the dislocated families, who were formerly neighbors, along with the change from rural to urban space and lack of yards in the new homes are factors that contribute to the families' feelings of uprootedness and not belonging to the new space. The communities also express an almost idealized vision of their lives in the villages prior to the disaster, showing a desire for having the new settlements as similar as possible to the ones they lost [Barreto, Rosa & Mayorga, 2020].

Tab. 1. Classification of the temporary houses in Mariana according to risk and habitability

Inspection Date	Adequate	Geotechnical Risk	Environmental Risk	Uninhabitability	No Information	Total
2018	88	32	8	56	0	184
July 2020	93	22	9	57	3	184
February 2021	95	19	9	57	4	184

Source: Data collected from Ramboll (n.d.b) and Ramboll (2021a)

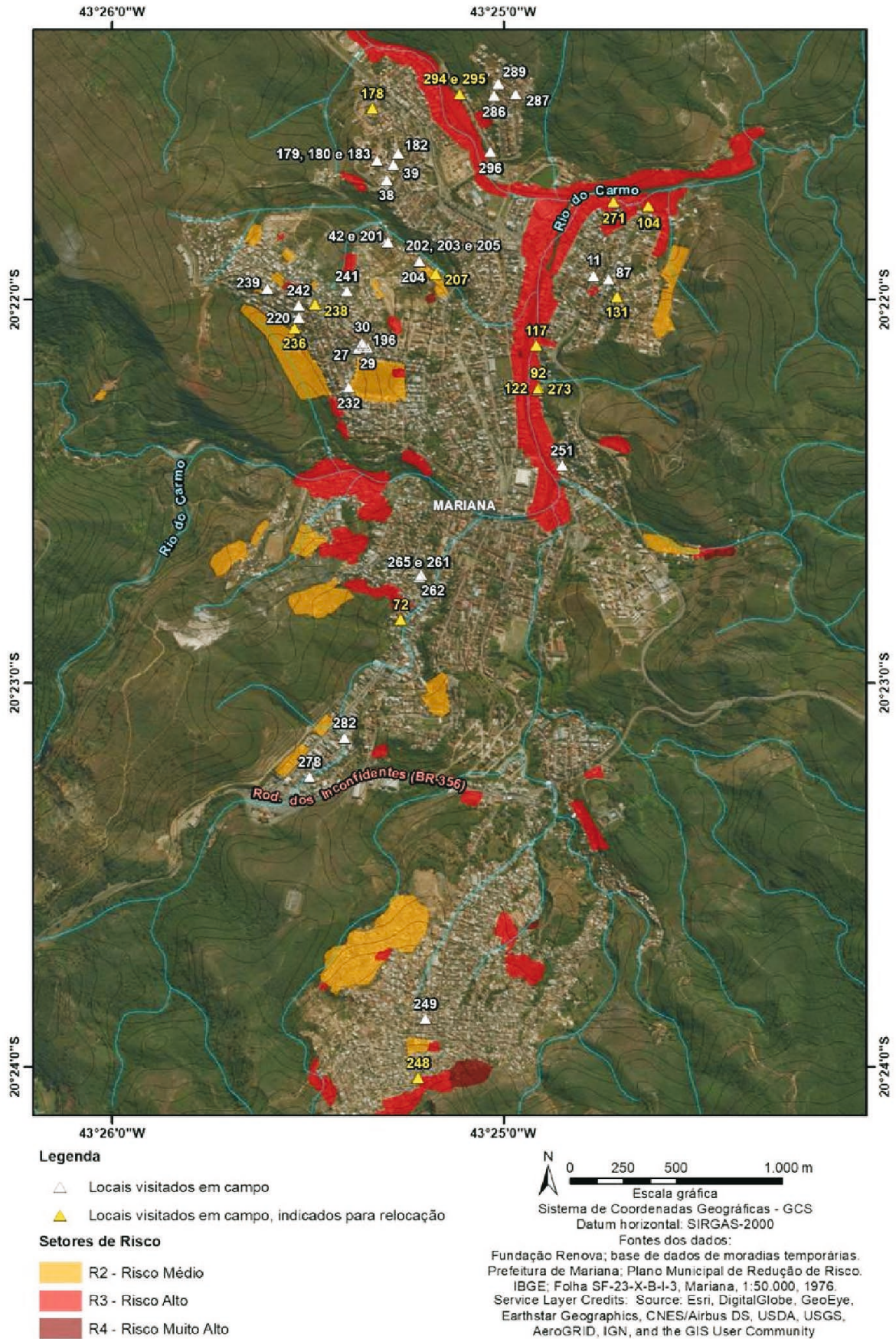


Fig. 6. Location of the temporary houses visited by Ramboll in Mariana (white and yellow triangles); source: Ramboll (2019)

5. TTAC: TRANSACTION AND CONDUCT ADJUSTMENT TERM

The *Termo de Transação e de Ajustamento de Conduta* (TTAC) is an agreement signed in March of 2016 between the Union, the state of Minas Gerais, the state of Espírito Santo, and other governmental agencies, and the companies Samarco, Vale, and BHP. This agreement establishes programs that aim to recover the environmental and the socioeconomic conditions that existed prior to the rupture of the Fundão tailings dam and its consequences. These programs would be developed and executed by a new autonomous foundation, founded by the companies Samarco, Vale, and BHP. This foundation would be supervised and have its actions validated by an Interfederative Committee, known as CIF, constituted by the public authorities [TTAC, 2016].

This agreement was criticized by the Federal Public Ministry (MPF) in numerous occasions [*Ministério Público Federal* (MPF), n.d.]. The Public Ministry claimed that the agreement protected the companies' assets over the affected population and the environment (MPF, 02 March 2016), and the regional attorney of the republic criticized the lack of public participation in it [MPF, 29 May 2016]. The population affected by the dam rupture was against the agreement as well [CNDH, 2017]. According to MAB (2016), although the

agreement mentions the participation of the affected population numerous times, it does not clearly establish how such participation would take place and does not guarantee the participation in the decision-making parts of the process.

The foundation created by Samarco, Vale and BHP received the name of *Fundação Renova* and is responsible for the development of 42 programs, which were divided in two categories: socioeconomic programs (programs 1 to 22) and socioenvironmental programs (programs 23 to 42). In the socioeconomic category, Program 08 is dedicated to the reconstruction, recovery, and relocation of the villages of Bento Rodrigues and Paracatu de Baixo, both in the municipality of Mariana, and Gesteira, in the municipality of Barra Longa [Fundação Renova, n.d.a; TTAC, 2016].

6. PGO8: RECONSTRUCTION, RECOVERY, AND RELOCATION OF BENTO RODRIGUES, PARACATU DE BAIXO, AND GESTEIRA

The program for the reconstruction of the villages of Bento Rodrigues, Paracatu de Baixo and Gesteira is established in the TTAC in subsection II.1, clauses 76 to 78. The program's actions are determined in clause 77, translated bellow in Table 2.

Tab. 2. Translation of Clause 77 of the TTAC defining the actions of Program 08.

CLAUSE 77 The following actions, to be developed by the FOUNDATION, are part of this PROGRAM:
a) choice, along with the communities, of the new location for the resettlement;
b) acquisition of the areas chosen along with the communities;
c) design and approval of the urban project and other engineering deliverables of the new settlement;
d) deployment of energy, water, sanitation, street, paving, drainage, and access infrastructures;
e) design and approval of the architectural project and subsequent real estate construction;
f) resettlement of public buildings, such as schools, health centers, squares, covered courts and religious temples, equivalent to the PREVIOUS SITUATION and in compliance with the public policy standards;
g) demolition of remaining structures and subsequent cleaning;
h) collective negotiation in a participatory instance to define the location, discuss the PROJECTS and monitor the construction work;
i) depending on the peculiarity of each specific case, the possibility of assisted self-resettlement, exchange and/or indemnification for the IMPACTED who so desire will be considered; and
j) provision of temporary housing for the displaced people for a period of up to 3 (three) months after the definitive solution for their housing.

Source: Translation by the authors from the original in Portuguese taken from TTAC [2016, pp. 48-49]

In clause 78, the TTAC defines that the rebuilding of the villages should be finished in 36 months counting from the signing of the agreement, in March of 2016. This, along with clause 77j, indicates that the initial prediction was for people to stay at their temporary houses between three years and three months and three years and six months, considering that the families started being settled in the temporary houses in November 2015 and would be able to move to the permanent settlement from March to June 2019. However, until this date, June 2022, the construction of the permanent settlements is not finished.

7. RESETTLEMENT OF THE DISLOCATED PEOPLE

There are four modalities regarding the resettlement of the displaced communities from the villages of Bento Rodrigues, Paracatu de Baixo, and Gesteira, and the rural communities hit by the mud wave in Mariana and Barra Longa. These modalities are collective resettlement, family resettlement, reconstruction, and indemnification [Ramboll, n.d.a].

Collective resettlement is the resettlement of the dislocated families in the new villages built by Fundação Renova, while family resettlement is the resettlement of each family separately, outside of these villages. The families that opt for family resettlement can choose to be resettled anywhere in Brazil [Ramboll, n.d.a].

8. RESETTLEMENT OF THE COMMUNITY OF BENTO RODRIGUES

As mentioned previously, the village of Bento Rodrigues, in the municipality of Mariana, was the one closest to the Fundão tailings dam and the one which suffered the most direct damage from the dam's failure and subsequential tailings flow [Carmo *et al.*, 2017]. The village had approximately 600 inhabitants according to most of the researched accounts.

According to a report issued in 2019 by Ramboll (n.d.a), 91% of the families from the community of Ben-

to Rodrigues in the resettlement program chose the collective resettlement modality. This figure dropped to 83% in June 2020 and to 78% in March 2021, even with the rise in the number of families in the program [Ramboll, n.d.b; Ramboll, 2021a]. In April 2022, only 209 families were in the collective resettlement modality [Fundação Renova, 2022], 42 less than in 2019 (Ramboll, n.d.a). Detailed data on the modalities chosen by the families of Bento Rodrigues are shown below in Table 3.

Along with the drop in adherence to collective resettlement, dropped the dissatisfaction of the community with such modality. Within the families that chose this modality the dissatisfaction rate went from 40.6% in September 2019 (102 out of 251 families) [Ramboll, 2020], to 24.3% in September 2020 (58 out of 239 families) (Ramboll, 2021a), and then 15.7% in March 2021 (36 out of 230 families) [Ramboll, 2021b].

There is a possibility that these data are correlated: the dissatisfaction of the families with collective resettlement could make more families opt for family resettlement, bringing a drop, therefore, in the percentage of dissatisfied families in the collective resettlement modality. This possibility is also discussed in the report of April 2021 made by Ramboll (2021b) to the Federal Public Ministry. Furthermore, according to *Cáritas Brasileira Regional Minas Gerais* [Cáritas, 2021], the migration of families to the family resettlement modality indicates that the dislocated people are hopeless due to the several delays on the final date of delivery of the new settlement to the community.

The drop in adhesion to collective resettlement by the families of Bento Rodrigues should be regarded with concern. The fewer people opt for collective resettlement, the lower is the prospect of maintaining or reestablishing the community's social ties and culture. On the other hand, the higher the percentage of families that opt for this modality, the better are the chances of the resettlement program to be successful in reestablishing the conditions and the way of life existent in the village prior to the disaster.

Tab. 3. Bento Rodrigues: families' resettlement choices.

Date	Collective	Family	Reconstruction	Indemnification	Total of families
2019	251	21	0	3	275
June 2020	239	43	0	7	289
March 2021	230	57	no data	no data	294
April 2022	209	no data	no data	no data	no data

Source: data collected from Ramboll (n.d.a; n.d.b; 2021a) and Fundação Renova (2022)

9. RECONSTRUCTION OF THE VILLAGE OF BENTO RODRIGUES

According to Samarco [Samarco, 02 May 2016], the company mapped 17 possible lands for the reconstruction of Bento Rodrigues following such criteria as: site accessibility, soil characteristics, water availability, and topography. The community of Bento then narrowed the possibilities down to three: the lands known as Lavoura, Carabina, and Bicas [Samarco, 02 May 2016], which can be seen in Figure 7.

The community of Bento Rodrigues visited the three lands [Samarco Mineração, 02 May 2016] and, on May 7, 2016, chose through vote Lavoura as the new land for collective resettlement. Representatives of 223 families out of 236 were present, amounting to 94% of participation, and Lavoura was elected with 206 votes, or 92% of the votes [Vale, 09 May 2016; Samarco, 2016a; Freitas, 07 May 2016]. However, since it was allowed only one vote per family through the figure of the head of the family, who was male in most cases, the rights of participation of women and adolescents in the selection of the new location of the village were not respected [CNDH, 2017].

According to a study made by Samarco (n.d.b), Lavoura is located 8.94 km away from the original village of Bento Rodrigues and 7.87 km away from the city of Mariana. Also, it is only 1.88 km away from Mariana's landfill [Samarco, n.d.b], which, according to Barreto,

Rosa & Mayorga (2020), was being used as the city dump. The proximity of Lavoura to the landfill raised concerns about this being the location chosen for the new settlement (Souza & Paaz, 2019; Xavier, 2018). These concerns were aggravated by the fact that Lavoura is located below the landfill and the same water course runs between both areas [Cáritas Brasileira Regional Minas Gerais & Comissão de Atingidos e Atingidas pela Barragem de Fundão (Cáritas & CABF), 2021].

The landfill issues were addressed by a technical study on the environmental health and soil quality of the terrain [Cáritas, 2017 *apud* Xavier, 2018], and by the signing of a term of commitment between Fundação Renova and the Mariana City Hall, where the foundation agreed to make the necessary interventions to ensure the proper functioning of the landfill before the resettlement of the community [Fundação Renova, 09 October 2018].

In June 2016 Samarco made a survey on the expectations of the community of Bento Rodrigues for the new settlement and houses, with 92% of the families present. The survey would be used as support for the architectural and engineering projects made for the new village [Samarco, 2016b]. According to Xavier (2018), the first project was presented in November, but the population claimed that it was not adequate to their way of living and that it was similar to a gated community.



Fig. 7. Location of the three possible lands for the new Bento Rodrigues; source: Samarco (02 May 2016)

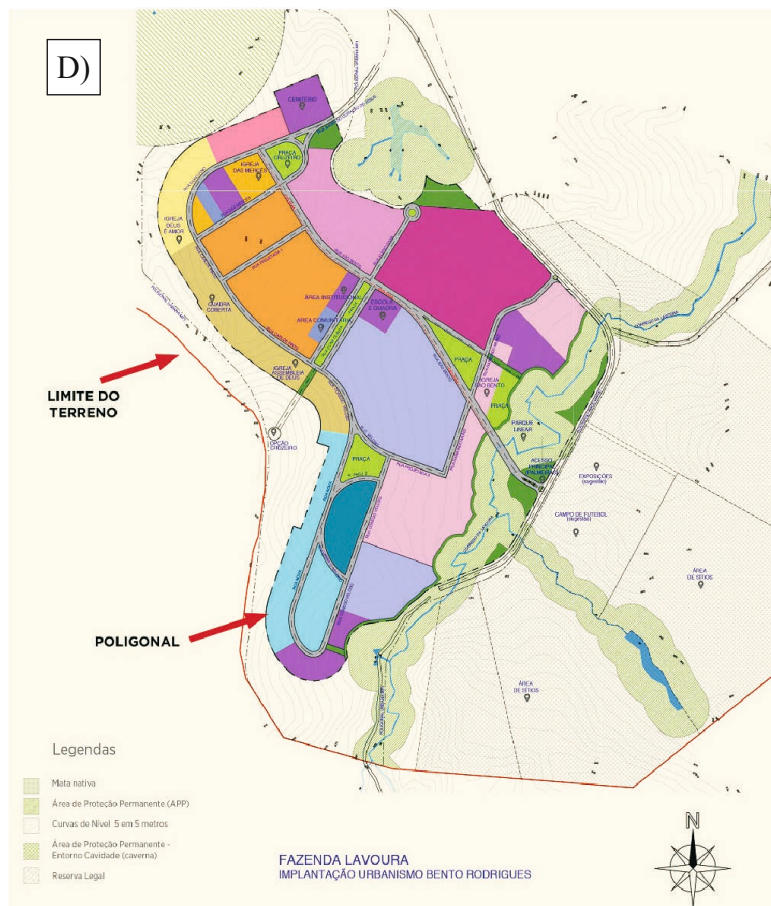
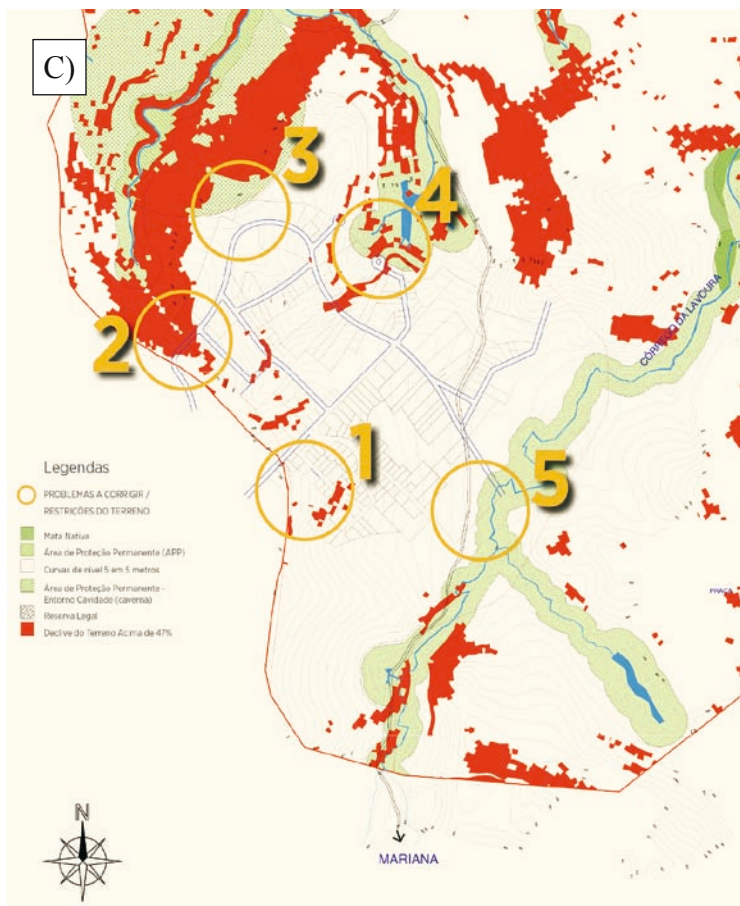


Fig. 8. Design process of the concept for the new settlement of Bento Rodrigues approved in assembly in January 2017. (A) Original urban plan. (B) Urban plan adapted to current legislation. (C) Conflicts between the urban plan and the terrain of Lavoura. (D) Final urban plan adapted to the new terrain; source: Adapted from Fundação Renova, Dávila & Synergia (n.d.)

Fundação Renova then developed a new urban conceptual project that was unanimously approved during an assembly that involved 190 of the dislocated families, a total of 80% of the eligible families, in January 2017 (Fundação Renova, 31 January 2017). In order to respect the voting rights of all the dislocated people, the criteria for this vote were different than the ones for the terrain election. Thus, the quorum count was made by the family, where only one representant per family had to be present. However, every Bento Rodrigues resident older than 16 years old was allowed to vote [CNDH, 2017].

The approved project was based on the original design of Bento Rodrigues, which went through adaptation to comply with the current legislation (e.g., streets at least 10m wide, blocks shorter than 200m, land lots facing the street) and the available areas and restrictions present in the terrain of Lavoura [Fundação Renova, Dávila & Synergia, n.d.; Xavier, 2018]. The design process is summarized in the images of Figure 8.

However, the topography of Lavoura was different from the one of the original village, hence the terrain would have to undergo substantial earthwork for the construction of the new settlement. In June 2017, the environmental government agencies and CIF rejected the project. It would have to be better adapted to the topography of the site, diminishing the amount of earthwork, and be placed in a flatter area [Xavier, 2018].

Until mid-2017, about 19 versions of the urban design for the village had been presented [Xavier, 2018]. Also, the efficacy of the community participation in this process was questioned, since the plans were presented to the population with graphic and oral technical languages that were not easily comprehended by the dislocated people [Xavier & Carneiro, 2020].

According to Xavier (2018), the State Secretariat for Cities and Regional Integration (SECIR) and the State Secretariat for the Environment and Sustainable Development (SEMAD) determined the organization of workshops by Fundação Renova in order to optimize the urban design process and include the dislocated families in it. These workshops took place from 14 to 28 November 2017 and consisted of discussing, with the assistance of two models (Figure 9), two urban design projects with the families. The aim was to gather information on the families' perceptions of the best and worse qualities of each project and use this information later to produce a new urban design [Xavier, 2018].

Each project was presented and discussed with the families separately. The first project was presented by a professional from Fundação Renova, then professionals from Cáritas discussed it individually with each family, adding information on their specific land lot, neighbors, among others, and finally the families exposed their opinions and suggestions on the project (Figure 10). Then the same process took place with the second project [Xavier, 2018].

On February 8, 2018, a new urban design was approved by 99.4% of the dislocated families of Bento Rodrigues (Figure 11), with 179 out of 180 votes. According to Fundação Renova, the project preserves the original characteristics of the village and its patrimonial, urban, and cultural aspects as much as possible, especially in regard to the neighborhood relations. This project is a result of the workshops that took place in November and had the participation of 164 families [Fundação Renova, 09 February 2018].

The approved design kept the structure of the original Bento Rodrigues village with the main street, the São Bento Street, running from North to South. It also placed the Church of São Bento at one end of the street and the Church of Nossa Senhora das Mercês at the other, among other spatial references to the old village. However, the different topography leads to very different results regarding the spatial relations established in the village [Teixeira, Medeiros & Pereira, 2020].

The visual axis that previously existed between both churches, for example, ceases to exist in the new village because of the different topography, as can be seen in Figure 12. The proposed urban design also creates different types of land lots. In the original Bento, the lots located along São Bento Street were roughly on the same level of the street. In the new village, those lots are terraced, which makes the yard of the houses difficult to access [Teixeira, Medeiros & Pereira, 2020].

As of June 2022, the construction of the village of Bento Rodrigues is not yet finished, therefore no families of the collective resettlement modality were permanently resettled. As for the families that chose the family resettlement modality, some have received their permanent houses, however, no information on where such families were from originally (Bento Rodrigues, Paracatu de Baixo, Gesteira or rural communities) was found [Fundação Renova, n.d.b].



Fig. 9. Models in scale 1:750 used in the workshops with the dislocated families of Bento Rodrigues. (A) Project 1 for Bento Rodrigues. (B) Project 2 for Bento Rodrigues; source: Celiane Xavier [Xavier, 2018].



Fig. 10. Feedback board colored blue for positive feedback, yellow for negative ones, and green for suggestions on the urban designs presented to the families; source: Celiane Xavier [Xavier, 2018]

Projeto Urbanístico do Reassentamento de Bento Rodrigues

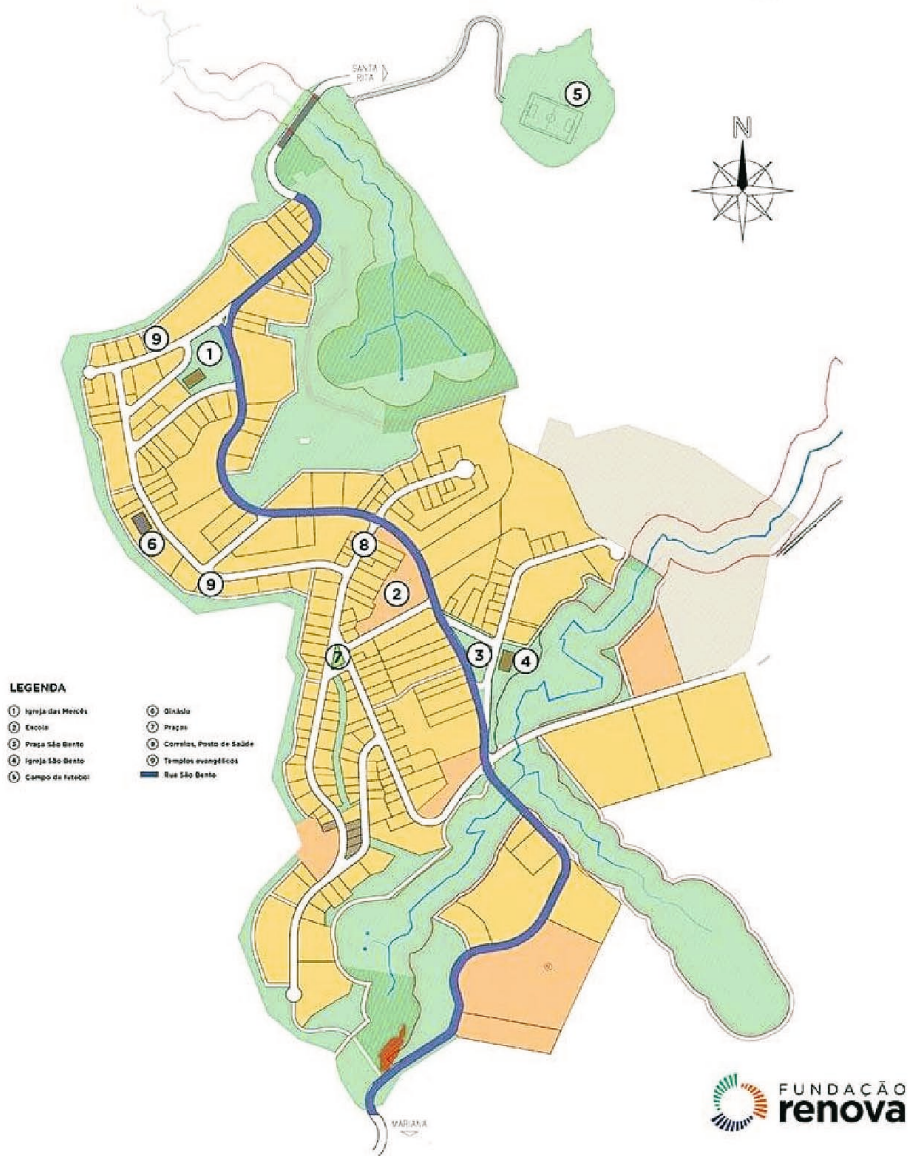


Fig. 11. Approved urban design for the resettlement of the village of Bento Rodrigues. (1) Church of Nossa Senhora das Mercês. (2) School. (3) São Bento Square. (4) Church of São Bento. (5) Soccer field. (6) Gymnasium. (7) Squares. (8) Post office, Health center. (9) Evangelical temples. (Blue) São Bento Street; source: Fundação Renova (09 February 2018)

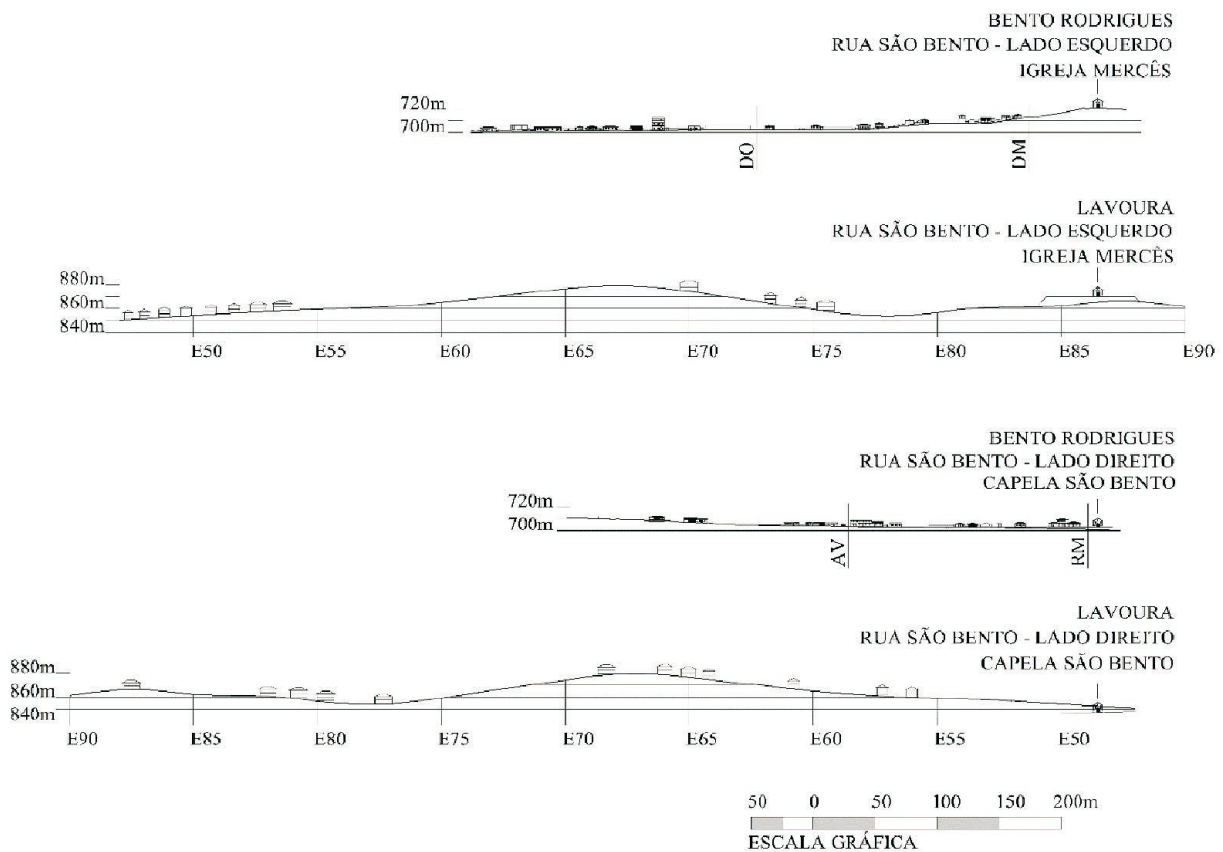


Fig. 12. Longitudinal profiles of São Bento Street in the old and the new Bento Rodrigues villages. (A) Left side profile of the old village. (B) Left side profile of the new village. (C) Right side profile of the old village. (D) Right side profile of the new village; source: Maria Teixeira, Mirelli Medeiros & Ana Pereira [Teixeira, Medeiros & Pereira, 2020]

10. DISCUSSION

The Bento Rodrigues resettlement operation is similar to the construction of a new city, involving not only the construction of houses and buildings, but also of all the infrastructure and services necessary for the well-functioning of a village. Forsyth & Peiser (2021) identify two main types of resettlements (or retreats, as they call it) involving comprehensively planned new settlements (e.g., neighborhoods, villages, towns) like the Bento Rodrigues one: whole community resettlements and new community resettlements. Whole community resettlement occurs when one community is relocated as a whole to a new settlement, while new community resettlement occurs when people from different places and backgrounds are resettled together in a new settlement [Forsyth & Peiser, 2021].

According to this definition, the resettlement of Bento Rodrigues was conceived as a whole community one, where the dislocated families would be resettled as a community at a new village, the new Bento, after around three years of living in temporary

houses in Mariana. This type of resettlement has the advantage of maintaining the community's social ties, as noted by Forsyth & Peiser (2021), which was one of the goals stated by the governmental authorities involved in the resettlement process and Fundação Renova.

Although the families could opt for family resettlement outside of the new village, or even for financial compensation, three years after the disaster more than 90% of the dislocated families still chose to be resettled as a community (Table 3). This was a good indicator for the success of the resettlement and a great basis to achieve the goal of maintaining social ties and culture, or at least facilitating their reestablishment. However, after the first deadline of resettlement was not met, in 2019, the adherence to the collective resettlement dropped each year, leading us to question whether this endeavor will succeed as a whole community resettlement or if there will be too few inhabitants for the social ties and culture to persevere.

This drop in adhesion after the failure of meeting the initially proposed resettlement date indicates that dislocated communities might compromise to waiting long periods of time in order to be relocated together; however, once the resettlement date is continuously postponed, the uncertainty of the future leads people to opt for dispersal (family resettlement in the case of Bento Rodrigues). Therefore, time is an important variable in whole community resettlement operations, and it is important to carefully assess the timeline of resettlement and abide by it, so that the expectations created in the dislocated community are met, increasing the adhesion to the collective resettlement and the chances of its success.

Along with the drop in adhesion to collective resettlement, the effects of the dispersal of the community in the temporary housing arrangement, the long period of time that families have spent in the temporary houses, and the change from rural to urban environment leads us to question to what degree the community of Bento Rodrigues will have maintained its social ties and culture – the biggest benefit of the whole community resettlement model – when it is finally resettled. Without maintaining these ties, it is possible that, although originally conceived as whole community resettlement, Bento Rodrigues' residents may need to recreate their social ties and culture in a similar manner to how a new community would. This, however, can only be assessed in the following months and years after the permanent resettlement of Bento.

One of the factors that can contribute to time saving in resettlement operations is the involvement of the displaced people in the process. Including their participation from the beginning can accelerate the resettlement process by reducing the amount of rework needed. The opposite of this happened with the Bento Rodrigues process, where the new village's urban design had to be reworked many times, with at least 19 proposals made according to Xavier (2018). Only after a more profound popular participation (required by governmental agencies) and the compliance of the presented masterplan with public policy standards was the final urban design approved, but only in February 2018 – more than two years after the disaster that caused the community's displacement.

The dislocated people's participation in the process is also important to guarantee some level of choice, since leaving their homes was not a decision they voluntarily made. Also, as stated by Forsyth & Peiser [Forsyth & Peiser 2021, p. 2], "currently many climate change related resettlement programs are voluntary but as time goes on the choice may be less whether to move but where".

Moreover, the participation of all dislocated people should be guaranteed. During the process, it is possible to divide people in groups and treat them as units, as were the family units in Bento Rodrigues. However, this should not be reflected in the participatory instances of the process, especially regarding decisions that affect the community as a whole. This will avoid situations similar to what happened in the Bento Rodrigues resettlement process, where people, especially women and younger people, were left out of the land choosing vote because the vote was by family instead of by person.

The displaced people, after being forcibly removed from their homes, may idealize their old village, houses, and way of life, and want everything in the new settlement to be exactly the same as it was previously, as signaled by Barreto, Rosa & Mayorga (2020), in Bento Rodrigues. This should be taken into consideration when designing the new settlement, and actions such as maintaining the same neighborhood relations, as was done in Bento, should be encouraged. However, simply copying the old village's plan and adjusting it to the new site is not necessarily the best approach. As seen in Bento Rodrigues, the resulting urban design may not fit the new land.

Also, when trying to copy the original plan, the result might be the creation of spaces and spatial relations that are very different from the ones that existed in the previous settlement. It is therefore also important to recognize the limitations of each tool used and combine more than one to consider all three dimensions in the design process. In Bento Rodrigues, for example, the biggest concern was with creating an urban plan similar to the original one, in an effort to maintain the same structure and building relations of the original village. However, this resulted in very different terrain profiles and cross-sections and, therefore, different spaces and spatial relations. In the case of the churches of São Bento and Nossa Senhora das Mercês, studied by Teixeira, Medeiros & Pereira (2020), it could have been more valuable to maintain the visual connection between both buildings than to simply place them in the same street, for example.

The urban and architectural designs should be inspired by and make references to the original ones, while providing an environment where the dislocated people can live a lifestyle similar to the one they previously had. These references can be done through the visual axis, streets' layout, squares configurations, landmarks, and public and service buildings placement, for example. It can also be done by giving the same names to the streets or numbers to the houses.

However, as shown from the Bento Rodrigues experience, the new design should consider the topography, resources and already existing structures and references of the new terrain, like any new urban design project should.

One of the challenges of designing whole community resettlement might be the communication with the dislocated people and their expectations. As seen in the case of Bento Rodrigues, the families had difficulty understanding technical language and tools, such as the masterplan – as expected of anyone not familiar with the urban planning field. Also, they expressed the wish of having the new village as similar to the old one as possible. These factors combined can help explain the decision to focus mainly on the plan when designing the new village, simplifying the process. However, it is important to find the means to discuss and design the new village in a more holistic manner. The workshops that took place in November 2017 and used models to communicate the urban designs to the dislocated families may present a hint on how this can be done in resettlement operations.

CONCLUSIONS

More than six years after the rupture of the Fundão tailings dam, no family has been resettled in the new Bento Rodrigues village, which is still under construction. This, along with the initial expectation of being resettled in approximately three years and the constant decrease in the dislocated families' adherence to collective resettlement are not good indicators for the thriving of the resettlement operation. Although the process is not yet complete and its success or lack thereof can only be assessed after its completion, we can already learn from it and use it as a roadmap for future resettlement processes.

After the analysis of the Bento Rodrigues case, it is possible to conclude that *time* is a very important variable in whole community resettlement operations of forcibly displaced communities. While waiting in appropriate temporary dwellings, a displaced community may compromise to be resettled in a few years in order to be placed in an environment similar to their original one. With this time, the process can involve stronger participation of the community and result in urban and architectural designs that better fit the community's needs and the settlement's new environment. This can generate a better end-result and increase the satisfaction of the dislocated population with the new settlement, since they will have participated in its conception and, potentially, its construction.

However, poor time management and ineffective processes may prolong the resettlement operation, leading to the postponement of the resettlement date. This situation may create insecurity in the dislocated community, leading people to opt for dispersal instead of waiting for a resettlement that is not guaranteed to happen within an acceptable timeframe – as seen in Bento Rodrigues (Table 3). This also leads to another important factor in these operations: *expectations*. It is important to set goals for the various stages of the resettlement operation and achieve them, in other words, it is important to meet the expectations set. In this way the dislocated people can measure the progress of the resettlement and feel secure in the process, therefore maintaining or even increasing the community's adherence to collective resettlement.

Both *time* and *expectations* management depend on good *communication* between the organizations responsible for the resettlement and the dislocated people and the community itself. Inefficient communication may lead to a lot of reworks and, potentially, the inability to meet the proposed deadlines. Poor communication can also create in the community expectations for the resettlement (e.g., the expectation that it will be exactly like the old one) that cannot be met, potentially leading to the dislocated people feeling disappointed and helpless with the result.

Once the resettlement process of the Bento Rodrigues community is finished, it will be possible to better assess how each of the variables discussed in this article have influenced it. Also, the monitoring of the community in the following months and years will give us more tangible answers on whether this process can be used as a model for future whole community resettlement operations of forcibly displaced people and where it can be improved.

This article makes an in-depth analysis of what happened to the population of Bento Rodrigues after the Fundão tailings dam failure, following the community's resettlement process chronologically from the moment of the disaster until the approval of the new settlement's urban design. By analyzing the multiple phases of the resettlement process (immediate action, temporary resettlement, and permanent resettlement), the article provides a comprehensive picture of the resettlement of the community. This will allow the analysis of the causes and consequences of this endeavor's successes and failures once the community is permanently resettled, which will be important information to have when dealing with a foreseeable growth in communities displacement due to environmental disasters and climate change.

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