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**URBAN RESILIENCE
IN THE FACE OF
THE 'DISASTER' OF
MARIANA-MG, BRAZIL**

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Abstract: The article proposes a reflection on the term “urban resilience” facing its already worn usage, as well as on the limits of its application in situations of catastrophic human occupations. The unpredictability of some natural and human events alongside with a strong repercussion on communities represent a sort of gap in the possibility of a technical analysis of the land. The notion of resilience, as in “sustainability”, seems weakened in relation to what is needed to build meaning to both urbanism and to develop actions of reversibility. Some highlights of the international experience are mentioned, which are then compared to the collapse of SAMARCO 's Dam in the city of Mariana (Brasil) in 2015. This comparison takes place through analysis of both the Environmental Impact Assessment (EIA) and the Transaction Agreement and Conduct Adjustment (TACA)¹ which guide the ongoing measures in order to recover and compensate the affected communities.

Keywords: Urban Resilience, Urban Planning, Mining territory.

INTRODUCTION

This article proposes a critical discussion on both the notion of “resilience” of a territory and its suitability in order to formulate plans and projects, after potentially destructive events of human occupations, focusing on situations related to mining dams. The case of the collapse of the Samarco Dam, in the municipality of Mariana, State of Minas Gerais- Brazil, is highlighted, which took place in 2015. The notion of resilience has been used in a wide range of meanings, which are to be seen in several publications, studies and legal instruments, but, very often, it is associated with actions to minimize impacts in areas of risk and situations of vulnerability,

which take place after events of natural origin or induced by anthropic action.

A reorganization of the international production of Capitalism, as well as its social reproduction were becoming clear since the 1970s and more emphasized from the 1980s onwards. This reorganization guided the logics that resulted in the emergence of a growing ecological crisis, *pari passu* with widespread concern with the environmental issue. Among the various consequences of this crisis are the destruction of tropical forests; increased air pollution, global warming; the pollution of both fresh and salt waters; the loss of biodiversity, among many others. In this context, the term “sustainability” emerges, which has become better known since the World Economic Forum, although it had already been used since the formulation of the Brundtland Report (1987). In global debates on such environmental issues, this term appears more frequently in the media around the 1990s, in particular, on account of the United Nations Conference on the Environment and Development, held in 1992, in Rio de Janeiro.

The term resilience, on the other hand, starts to gain in importance only in the last decade. In this sense, although first introduced in 1973 by the American ecologist Crawford Stanley Holling, only in the 1980s-1990s it began to be mentioned in various reports on impact prediction, a concept embodied in the regulation of Environmental Legislation in Brazil, from the 1990s onwards. The sense of “resilience”, linked to a response to events with a greater degree of unpredictability, such as typhoons, earthquakes, nuclear and oil accidents, with serious ecological consequences, is even more recent, and it has been used in association with emergency measures in the face of intensive transformations of the landscape and

¹ TTAC (Termo transitório de Ajustamento de Conduta), from the original language (Portuguese), refers to a legal document for the adjustment of environmental conduct.

environmental and socioeconomic dynamics in a given place or region. It stands to the public administrators as a type of promise of mobilizing forces to reverse the scenarios of human, environmental and material losses and thus resume a certain normality previously experienced.

Although the etymology of the word, originally associated with physics, has gained other connotations, it does not seem to have abandoned the meaning of a body's ability to recover, after undergoing certain deformations, keeping its initial state as a reference¹. Thus, transposed to the idea of urban resilience, the term would capture a meaning of undertaking actions in order to prepare measures, in a given location, with the purpose of increasing its recovery capacity after potentially unpredicted and catastrophic events. But would it be possible and desirable to return to the conditions of 'normality' prior to catastrophic situations?².

The notion of resilience is examined here when approached to urban situations, and, in particular, in the case of the collapse of the Samarco dam in Mariana, in 2015. It is known that this occurrence had dramatic consequences not only in the district areas of the communities located downstream the dam, but it also had regional impacts along the entire length of the Rio Doce Valley. For this analysis, some procedural aspects related to this impact were highlighted, in order to show that this territory did not have prior preparation for events of this scale, which were both desirable and necessary, given the breadth of mining investments in its territory. Thus, as mentioned above, the possibilities of achieving a possible territorial resilience were reduced. In this sense, it is proposed to consider two aspects on this issue: (i) the insufficiency of the term to engender the territorial possibilities of reparations to those affected; and (ii) the weakness in adopting

and formulating compensation measures, as a result of the accident, to build a vision of the future for the region.

Therefore, the objective of this article is the following perspectives: (a) detect some theoretical advances in relation to the concept of resilience applied to cities and examine practices arising from these advances, especially from the perspective of applying the accumulation of knowledge in 'disaster' situations, also from different origins; (b) verify whether the measures taken before and after the Mariana dam collapse are similar to the idea of urban resilience, and how this reflection could reposition its applicability in similar cases³.

In order to carry out this study, documents from available official sources were analyzed, in addition to the authors' own repertoire, based on practical professional experience in the study region, in the analysis of the socioeconomic and urban-environmental impacts of mining in the municipalities of the Iron Quadrangle of Minas Gerais. Once the texts, images, graphics and other sources of information on events similar to the Mariana-MG disaster were gathered, they were confronted, using the meanings that the word "urban resilience" can assume not only in articles and academic studies, but also in the media. Thus, it is believed, from now on, that a concept can be a powerful tool, as it reveals possible layers of reading and interpretation, and also as it metaphorizes itself together with other fields of knowledge, gaining other meanings in narrative practices.

Resilience⁴ has its original meaning linked to physics and has migrated to other disciplines such as psychology, administration, social sciences and geography. It has also been applied to biology, becoming part of ecological theory, in observation of the capacity of interference of its ecosystems, when subjected to certain disturbances, without significantly altering its

structure, possibly returning to its previous state⁵. This concept has become popular, and it approached urban studies through its incorporation into technical vocabularies, sometimes committed to explanations based on a scientific discourse, which are often linked to the idea of returning to a certain original situation.

Resilience as a purpose to be achieved through the restoration of initial, post-disaster situations in urban areas, proves to be quite problematic, as it does not seem to take into account the complexity of places and their history. Besides this, the different temporalities of the agents producing that space can give rise to different orientations to the measures to be undertaken in the post-disaster reconstruction process, when the above conditions are observed. Cities are constantly changing. In Mariana's case, whether due to the apparent lack of empirical experience of local leaders in dealing with the unprecedented 'disaster', or due to the scale and scope of the event, the collapse of the Samarco dam becomes an emblematic case, which must be monitored, over time, in order to assess the possible applicability of the concept of urban resilience in the national context and in similar situations.

SOME RELEVANT REFERENCES FOR THE RESILIENCE DISCUSSION

Some referential conditions were identified for the discussion of the concept of urban resilience throughout the studies of disasters, and will be presented here, such as: the importance of the recovery process, early planning, how popular participation is committed to this planning and the need for a positive trajectory to resilience.

JOHNSON; OLSHANSKY (2016 p.3)⁶, in the publication "After great disasters", conduct a deep analysis of how six countries managed the recovery of population groups affected by

natural disasters. They point to the importance of focusing on the recovery process and its opportunities to fix structural problems, such as renovating infrastructure, creating new land use arrangements, reinventing economies and improving governance. Managing this process is an important aspect, as it can affect both the intensity and duration of post-disaster experiences. In general, in the examples studied, it is only after a disaster occurs that the leaders of the affected communities recognize that they do not have relevant experience to lead the recovery process, as well as the importance of systematizing these experiences.

One of the main issues that seems to confront the idea of resilience, in the strict sense of a return to "original conditions", concerns whether or not this return is desirable. We know that urbanization processes in societies like Brazil, severely marked by socio-spatial inequalities, are incomplete (SANTOS, 1978)⁷. It is plausible to consider that many situations do not suggest a return exactly equal to the previous conditions, marked by socio-spatial vulnerability, and, therefore, require other ways of listening to the voices of the territory. But what are the fundamental aspects of the situations observed in the post-disaster? Would it still be possible to create a certain model? Such questions raised here can also make part of concerns of local leaders, given the affliction and suffering of many and the need to mobilize efforts to take the first steps, such as: emergency care, rehabilitation of basic infrastructure in order to create access to impacted sites, housing construction, among other measures. The systematization of experiences can be an initial resource, a compass, but also just a starting point to guide efforts, in the face of human, environmental and material losses.

One of the milestones in the critical production process on this subject was the

International Symposium on Reconstruction after Earthquakes, held in 1990 and published in 1991, under the title “Rebuilding After Earthquakes. Lessons from Planners” by William Spangle⁸. This document lists the main stages of the processes involved and a time perspective for the reconstruction of the affected housing and equipment. It also points out that a set of local and regional development plans, normative or not, must be ensured in the pre-earthquake stage, considering temporary housing, historical preservation problems, people’s safety, and disparate effects on local businesses, among others. He also highlighted the need to create a local authority figure for the matter. The centrality of the idea of planning is evident in the symposium’s conclusions (SPLANGE, 1991)⁹.

Planning requires reflection on certain scenarios. In this context, it is a question of examining possible aggravations of territorial risks that demand operating models, not as final parameters, but as technical and scientific accumulation of territorial knowledge and other reflections. Thus, two concerns are raised: (i) the definition of clear objectives, time frames and stages for a final scenario, but which can bypass territorial diversities; and (ii) by focusing efforts on setting goals, it is possible to reduce the possibilities of re-articulation of specific and multiple conditions, taking into account the time of their local agents. In any case, the discussion on urban and territorial resilience goes through the assessment of opportunities to overcome systemic and structural problems, verifiable in the pre-disaster situation.

It is in this process of recognizing the technical conditions at a given moment that popular participation has been incorporated, in the case of Brazil, especially seen in Municipal Managing Plans (local guidelines), after the Statute of Cities, a Federal Law

instituted in 2001. In addition, urban planning, as well as planning at a regional scale, can take on a wide range of objectives, including that of protecting the community from climatic and geological risks. Thus, both the notions of planning and resilience come together in anticipating certain undesirable conditions, through statistical and trend forecasts. But, in this sense, an attempt to excessively control territorial variables, not entirely known, might not be enough. This position of greater control – often illusory and out of step in relation to changes in reality – falls with criticism, not only academic, but based on empirical experience in other parts of the world, given the accelerated transformations of socio-territorial dynamics.

As for the second question, related to the first one, it is about the perspective of acting in so-called scenarios of uncertainty (SABATÉ, 2008 p.10)¹⁰, more capable of adapting to changes and the unpredictability of multidimensional relationships in geographic space. The emphasis lies on processes and not on specific goals. In the document from the Lincoln Institute, published in 2016, this conceptual transformation is presented, giving another understanding to the idea of resilience after major disasters. It reinforces the idea of the tendency of communities to self-organize, which adapt to change and increase their complexity over time when not managed by an external source.

Many authors have been working on the perspective that local communities are the most important agents of urban resilience, as they bring, in themselves, the ability to adapt as inherent and dynamic attributes of community life (CARRI, 2013; GOLDSTEIN, 2012)¹¹. This is called “community resilience”, a term used to characterize the collective ability to recover after crises. Adaptability is at the heart of this attribute, and accommodation processes can occur as a response to a crisis

or in anticipation of it. The community adapts to adversity, changing its organization. Its resilience would be reflected by the amount of adversity that could be overcome. There is a consensus that adaptations must improve the community, i.e. they must have a positive result (positive trajectory) for the community in relation to its condition prior to the occurrence of adversity, especially for the cases of communities impacted by actions derived from anthropic processes. It remains to define the meaning that the idea of a positive trajectory can present, which is understood here as the remobilization of community forces to restore the political meaning of the territory.

RESILIENCE AND SUSTAINABILITY - AN ABSTRACTION FOR THOSE AFFECTED

Another concept that comes close to “resilience”, and is often approached together, is sustainability. Despite the dissemination of these concepts, the imprecision of their use has been their hallmark. However, the word resilience, indicative of notions linked to ecology, is less known than its counterpart sustainability. This term still seems limited only to certain agents, such as academic, technical or governmental institutions and NGOs.

This poses an additional obstacle to the inclusion of a large part of the population into the debate. Although the recurrence of the word cannot say much about its conceptual appropriation, it is possible, in everyday observation, to see an increase in its application. Although this is only a very partial indicator of the number of people who would read this news, if we consider the scope of the newspaper analyzed in **Figure 1** (Folha de S.Paulo newspaper collection), it is still necessary to recognize that many of the decisions involving the situations of

natural disasters and of other natures have been supported in this concept, even though it is still little known to the general public. Thus, drawing up plans and norms guided by concepts that are still far from public appropriation becomes ineffective not only in terms of the possibility of a broader reparation for affected populations, but also in restoring damage and other material and immaterial damages.

The graphs in **Figure 1** compare the recurrence of the words “resilience” and “sustainability” in journals and publications accessible through the Google search tool. Even though it is still insufficiently known by the general population, the term ‘resilience’ in the surveyed journal is more recurrent as of 2016. When compared to the word ‘sustainability’, it stands at the levels seen in 2002, which indicates a possible lag of approximately 15 years.

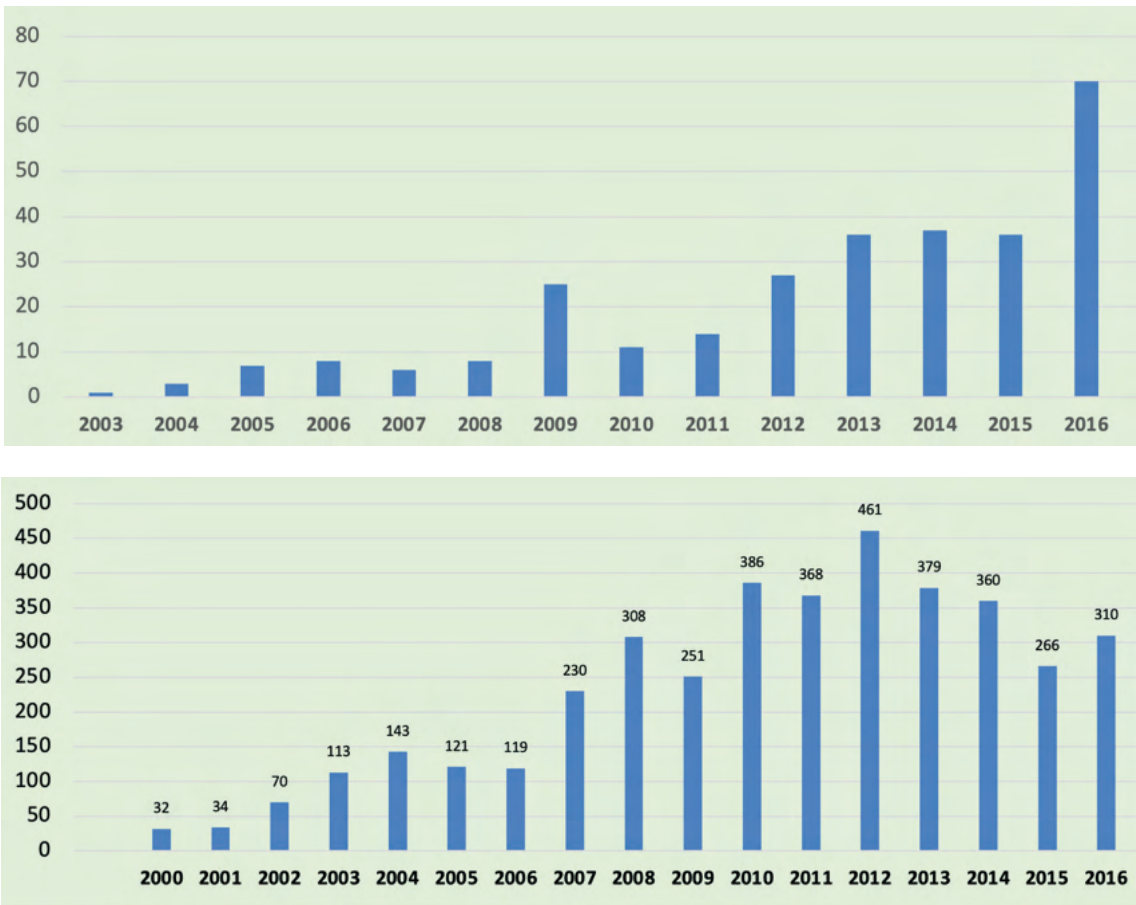


Figure 1 - The recurrence of the words “resilience” and “sustainability” in Folha de S.Paulo, since 1921.
 Source of the information: <https://acervo.folha.com.br/index.do>

According to these graphics, the usage of the word “sustainability” seems to differ in frequency of use and degree of assimilation. The written media, when introducing its meaning to the reports and the sample checking, shows its predominant application in environmental and economic senses. In both, it seems to carry notions that go beyond the sense of ‘sustaining’, ‘supporting’ – in the physical sense – and pointing to the restoration of certain balances. And, not as much for the economy, but rather for the environment, this balance extends to a vision of everything that surrounds us, our local precinct, connected to cycles and global systems.

Sustainability is no longer an unknown word. If it was, it would have worn away. It became a kind of magic formula, emphasized

more in speeches than in practices. It depends, like the concept of resilience, on the constitution of preconceived and socially accepted notions – as they provide quick answers to current afflictions, and refer to highly complex situations, which would require time-consuming and deeper reflections.

Thus, we could detect that the terms have been used as supporting structures in the formulation of practices and actions in a double sense: (a) the application of the concept of resilience in written news can point to the formulation of meaningless discourses, in the superficial use of the concept, from the meaning that is too much based on the instrumental rationalization of disasters and the indication of generic objectives and stages,

which say little about the specifics of each situation and, (b) the lack of familiarity with the word by the affected communities and the population in general would reduce the possibilities of discussion during participatory processes. They are often 'difficult' words, exotic to everyday life, distant and imposed as a last resort to endorse the actions proposed to the ills to which that population is subjected, often incidents in places where there is a greater concentration of socially vulnerable population.

URBAN RESILIENCE AND THE COLLAPSE OF THE SAMARCO DAM

As widely reported by the media, the collapse of the Fundão dam, owned by the company Samarco (2015), which occurred in Mariana, MG, produced extraordinary displacements of mud (ore tailings) downhill and a series of environmental, social and economic consequences - killed people, disrupted social and emotional bonds, caused secular damage to some ecosystems - also bringing up the issue of risk prevention and the existence of emergency plans. The preparation of the territory through the control of use and containment infrastructures or escape routes, and the operational training of the responsible company and the organization and training of communities to face risks could approach the notion of urban resilience, if followed by actions of confrontation, adaptation, restoration of conditions of normality, total or partial, in a trajectory of preparation for new extreme events.

In the case of SAMARCO's dam failure, evidence indicates that these conditions were not met. The analysis of the Environmental Impact Assessment and Environmental Impact Report (EIA-EIR) of the Fundão dam, presented in 2005, indicated problems with this licensing instrument in terms of preparing the territory to an effective condition of

resilience. Some aspects can illustrate this fact. The first refers to the analysis of the locational alternatives presented, in which the Fundão stream, chosen among two other alternatives (Natividade and Brumado streams), was the only one that would produce cumulative impacts with the other dams in the same microbasin, with possible dominoes effect, i.e. with enhanced risk (WANDERLEY, 2015)¹². This decision was possibly taken based on financial reasons, the lower cost of implementation, taking advantage of the rationalization provided by the existence of the interconnected mine system - Germano and Santarém (WANDERLEY, 2015)¹³. The second aspect would be the lack of other technological alternatives for the disposal of the tailings. Therefore, solutions that could be envisaged either in the planning or in the design phase, such as minimizing the generation of this waste through dry iron ore processing¹⁴, were not presented, with justifications only linked to increased productivity and cost savings. This capital management is often carried out during the formulation of speeches, sometimes in a threatening tone, and presented as a supposed impossibility of continuing the mining works in the municipality, if the proposed conditions are not accepted. This would lead to a serious reduction in budget revenue for the municipal administration.

A third important aspect refers to the dam failure risk assessment. The preliminary risk analysis pointed to an impact considered "unlikely". However, the analysis of previous cases, both in the world and in Brazil and more specifically in Minas Gerais, shows the highest frequency of this type of accident. In Minas Gerais alone, at a location very close to Mariana, two fatal accidents had already been registered: Itabirito, in 1986, with seven deaths; and Nova Lima, in 2001, with five deaths. Samarco's EIA-EIR instrument rules

out the possibility of dam failure and deaths in Bento Rodrigues. Thus, it does not analyze the worst impact scenario, which would be the tragedy of a dam failure and closure of mine operations, and, as a result, does not measure the magnitude and scope of impacts, nor does it mention the Rio Doce¹⁵; as well as the impact mitigation programs do not contemplate dam accidents.

On the other hand, in the analysis of the territory's preparation on how to acquire greater resilience, it appears that the region currently has many theoretical and technical instruments for an integrated reading of reality, despite eventual gaps. In the Iron Quadrangle, there are many examples of these studies that were intensified after the implementation of iron mining. However, in Mariana, the presence of studies in the area (with different approaches) was not enough to – in the face of a failure – minimize both material and human losses, from the point of view of its communication, prevention and emergency care systems. Thus, despite an advanced technical contribution, even capable of identifying and proposing actions in the face of a complex, multidimensional territorial reality, low effectiveness in the application of preparatory instruments similar to the concept of resilience for the reversal of destruction scenarios, losses and damages along the axis of the Rio Doce, from the Quadrilátero to the sea of Vitória, capital of the state of Espírito Santo can occur.

Regarding the application of the concept of resilience in the TACA - Transaction Agreement and Conduct Adjustment 16, the document (June 2017) presents forty-two socioeconomic and socio-environmental programs, which are under development by the Renova Foundation. This Foundation was created to manage the implementation of these programs. The TACA is structured around two main orders of measures to be adopted in

the face of impacts: repair and compensation. The socio-economic and socio-environmental remediation measures comprise parameters and actions with the objective of recovering, mitigating, remediating and/or repairing the impacts arising from the event, including indemnities; while compensation measures are intended to offset impacts for which recovery, mitigation, remediation and remediation are either not feasible or possible. (TACA – UNIÃO-SAMARCO, 2016, p.14).

Thus, the TACA uses the legal concepts of repair and compensation for the impacts caused by the collapse of the tailings dam in the constitution of the Programs. However, it emphasizes as a principle the repair of the previous situation, always written in capital letters. Its baseline is the “PREVIOUS SITUATION”, using as guideline the evidence through existing documents and records. At times the situation may even be measured afterwards, through evaluations, sometimes subjectively. In this sense, the positive trajectory of the impacted communities to approach the concept of community resilience is emphatically denied in the document, by incessantly reproducing throughout the clauses the repair of the “PREVIOUS SITUATION”, which disregards not only the experience of the impact on its resulting psychological and emotional component, but also the losses and the deterritorialization process to which the community of Bento Rodrigues was subjected.

From the perspective of urban planning, as a preparatory condition of the territory for urban and community resilience, it should be noted that the Managing Plan of the Municipality of Mariana, prepared in 2002 and updated in March 2014, did not mention any management guidelines for areas of mining risk. The zoning neither identified nor made any references to the flood spot in the event of a dam failure. Thus, the document

should establish restrictions on the use and occupation in the area now called “The self-rescue zone” by the Emergency Action Plan for Mining Dams - PAEBM, established by the National Mining Agency in 2017, as well as communication strategies that informed the communities subject to such risks.

PERSPECTIVES FOR UPDATING THE CONCEPT OF URBAN RESILIENCE

It is disturbing to perceive the weakening of words, either by reducing their meaning or by repetition to exhaustion, transforming them into wildcard words for contemporary human, urban and environmental afflictions. Sustainability has long made spectacular headlines in the general media and resilience seems to be taking the same path in the Digital Age. Where everything can be disposable, concepts should provoke suspicion and questions. In this brief journey, it was possible to detect, on the one hand, a movement to increase the meaning of the term, in international academic circles, supported by the observation of dealing with disasters and their learnings, and on the other, the premature emptying of this notion among the technical staff and academic, in general, and also when confronted in the measures specifically related to the case of the collapse of the SAMARCO Dam, in Mariana. This fact is demonstrated in the analysis of the EIA, which reveals limits in the preparation of the territory, by default, in anticipating adverse situations, in all possible scenarios, even if unlikely. And also, in the analysis of the TACA, which, despite having a fundamental role in legal mediation, is faced with a subjectivism mainly related to compensatory measures and a pulverization of specific measures. Returning to the previous situation seems to those affected to be little, given not only the losses and damages, but also the violence against Bento Rodrigues and

Paracatu de Baixo villages, among so many other locations downstream of the dam.

Recovering the process of constructing the meaning of the term resilience can take to the possibility of an urban environment more suitable to individual and community life after destructive events. But, despite the possibility of learning from related cases, this does not seem to constitute a standardized formula, but rather a more time-consuming process of reflection, which involves the dialogue of different social agents - including the Academia - to support the re-articulation of active local forces, enhancing interactions between affected communities and both the natural and built environment. A possible perspective for this would be the implementation of measures that preceded disasters and this, from now on, could be recommended to almost all situations of dams in the vicinity of occupied areas - urban or rural. It is also pointed out that the monitoring of indicators and territorial inspection are fundamental measures for the constitution of a baseline, for the process of rebuilding portions of the destroyed urban fabric and rebuilding ecosystems.

In Brazil, there is currently a National Civil Defense and Protection Policy (Law No. 12,608, of April 10, 2012), which regulates the “set of preventive, relief, assistance and recovery actions aimed at preventing disasters and minimizing their impacts for the population and restore social normality”. But a city with attributes of resilience - overcoming emergency situations - seems to generate its own possibilities for social reorganization, increasing its capacity to deal with urban complexities and not simplifying them. The adoption of the resilience model in Brazilian cities, an orientation of the Ministry of National Integration, cannot be seen only as prevention of possible accidents, but in its dimension of development and territorial

ordering. Such policies must be implemented at the territorial level, and must precede events, whether natural or anthropic, more or less predictable, with a long-term observation and auscultation of local issues, without losing sight of the comprehensive processes involved and their expressive content.

The economic response to urban resilience, especially in the Quadrilátero Ferrífero region, should take into account the mismatch between large capital (largely responsible for the GDP – Gross Domestic Product of extractive municipalities) and the informal family-based economy, which generates income. The concept of resilience for the region would immediately consist of recognizing structural disparities. The mining-metallurgical industrial activity that establishes a dynamic connected to the

supply circuits of world markets and the great accumulation of capital cannot minimize the importance of pre-existing activities in the reconstitution of commercial and subsistence activities. As reaffirmed in the studied reports, there is an old tension between mining activity and local life, an integral part of this region that emerged and was shaped by mining.

The application of these notions, still maturing, becomes an opportunity to change the paradigm for anticipating (more or less) unexpected events, preparing cities, in their specificities, for adverse situations, not only based on resilience, but also on a conceptual constellation to be constituted in time and space, as the historical and cultural construction of the territory, in its most untimely contingencies

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In addition to this issue, one important subject that will not be addressed in this article refers to the breadth, duration and depth of these actions, when confronted with acute cases of deterritorialization, as also verified in Mariana-MG. This deterritorialization was caused by involuntary resettlement processes, definitive or temporary, to which populations impacted by destructive events or various works were subject. The term is used here in the meanings presented by Milton Santos (1996), em “A natureza do Espaço” e “O retorno do território” (1994). SANTOS, Milton. A Natureza do espaço: espaço e tempo, razão e emoção. São Paulo: Hucitec, 1999; Santos M. O retorno do território. In: Território: globalização e fragmentação. São Paulo: HUCITEC/Annablume; 2002.

It should be highlighted that 4 years after the Mariana disaster, the Córrego do Feijão mine tailings dam, in the municipality of Brumadinho, state of Minas Gerais, controlled by the mining company Vale SA, shareholder of Samarco, collapsed on January 25, 2019. It was classified as “low risk” and “high potential for damage” by the company, and no occupation control action in the risk area along the Feijão stream had been implemented. The industrial, humanitarian and environmental disaster caused the death of 259 people and the disappearance of 11 others

Meaning indicated by Guatelli, I. in the article in the Revista da Pós Graduação at FAU USP, “Constitutive contaminations of urban space: urban culture through intertextuality and between”. São Paulo: FAUUSP, 2008.

The application of the term resilience (‘resiliens’ in Latin - jumping back, going back, being propelled, retreating, shrinking, breaking and ‘resilient’ in English, which refers to the idea of elasticity and quick recovery capacity) has been used for a long time in physics and engineering by Thomas Young (1807), describing experiments on tension and compression of iron bars and seeking the relationship between the force that was applied to a body and the deformation that this force produced (Pinheiro, 2004). Also used by other sciences such as medicine, resilience refers to a person’s ability to resist disease, infection, either through their own resilience or through the help of curative or preventive medication (Ruegg, 1997); for psychology, it has to do with the quality of human resistance and perseverance in the face of life’s difficulties (Schmied & Lawler, cited in Tavares, 2001; Rack & Patterson, 1996).” BARRIER, Diná Dornelles and NAKAMURA, Antonieta Pepe. Resilience and perceived self- efficacy: articulation between concepts. Aletheia [online]. 2006, n.23, pp. 75-80. ISSN 1413-0394

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This solution has already been adopted by Vale itself in Itabira, at the Conceição mine.

It is noteworthy that, as reported in both “O Globo” and “Estado de São Paulo” newspapers, the accident did cause serious impacts on the Rio Doce ecosystems, with an impressive mortality of fish and damage to the public water supply to many municipalities crossed by the river, covering more than 400 km to its delta. It also had repercussions on marine ecosystems, with the mud patch spreading for more than 15 kilometers north of the delta of the Rio Doce and 7 kilometers towards the south, affecting the Comboios Biological Reserve, which is a coastal conservation unit that protects the unique regular spawning point for leatherback turtles on the Brazilian coast.

UNIÃO-SAMARCO – Termo de Transação de Ajustamento de Conduta. 2016.

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