

EROSIONAL PROCESSES IN URBAN AREAS AND IMPLICATIONS FOR QUALITY OF LIFE

PROCESSOS EROSIVOS EM ÁREA URBANA E AS
IMPLICAÇÕES NA QUALIDADE DE VIDA

PROCESOS EROSIVOS EN ÁREA URBANA Y SUS
IMPACTOS EN LA CALIDAD DE VIDA

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Abstract

Countries with tropical soils tend to struggle with linear erosion phenomena by not adopting appropriate land use practices. Based on WHO standards, this qualitative research study examined the population living close to gullies in the city of Anápolis, Goiás state, Brazil. The study's main objective was to discuss new possibilities of addressing erosion, highlighting the influence of socio-economic and educational factors on its causes and outcomes. Seventy-two houses located around eroding areas were investigated in 2012, and in each of them an individual provided the interviewer with information regarding all its residents; this procedure resulted in a data set with information about 264 people. Data analysis produced a socio-economic profile of low educational level, underemployment, and low salaries, as well as deficiency in urban infrastructure and in access to urban and leisure services. Moreover, the analysis revealed that the population has difficulties in perceiving the physical environment of the places they live in as well as the inherent risks posed by existing impacts, e.g. gullies. This scenario exposes the imminent need for governmental actions concerning land use planning and environmental education (both formal and informal) which establish preventive measures against the emergence of linear erosion processes.

Keywords: Gully, soil, environment.

Resumo

Países com solos tropicais tendem, quando não adotam práticas adequadas de uso do solo, a sofrer com fenômenos de erosão linear. Esta pesquisa investigou de forma qualitativa, usando parâmetros da Organização Mundial da Saúde (OMS), a população que habita o entorno de voçorocas na cidade de Anápolis – GO. O principal objetivo da pesquisa foi discutir novas possibilidades de abordagem do fenômeno erosivo, evidenciando em suas causas e consequências a influência de fatores socioeconômicos e de educação. Em 2012 foram abordadas 72 residências no entorno de erosões, onde um representante conversava com o entrevistador fornecendo dados de todos os moradores da casa. Esse procedimento permitiu a aquisição de informações de um total de 264 pessoas. A análise dos dados revelou um perfil socioeconômico de baixa escolaridade, subemprego e baixos salários, bem como deficiência de infraestrutura urbana e de acesso a serviços urbanos e de lazer. Além disso, constatou-se uma dificuldade por parte da população em perceber o meio físico dos locais habitados, bem como os riscos inerentes aos impactos neles existentes, tais como as voçorocas. Tal situação demonstra uma necessidade eminente de ações governamentais de ordenamento do uso do solo e de educação ambiental formal e informal que permitam a efetivação de atitudes preventivas à instalação de processos erosivos lineares.

Palavras-chave: Voçoroca, solo, meio ambiente.

Resumen

Países con suelos tropicales, cuando no adoptan prácticas adecuadas de uso del suelo, tienden a sufrir fenómenos de erosión lineal. Esta investigación estudió, de forma cualitativa, usando parámetros de la OMS, la población que habita los alrededores de las cárcavas en la ciudad de Anápolis – GO. El principal objetivo de esta investigación fue discutir nuevas posibilidades para enfocar el fenómeno erosivo, evidenciando en sus causas y consecuencias la influencia de factores socioeconómicos y de educación. En 2012 fueron estudiadas 72 residencias situadas alrededor de las erosiones, donde un representante conversaba con el entrevistador proporcionando los datos de todos los habitantes de la casa. Ese procedimiento permitió la adquisición de informaciones de un total de 264 personas. El análisis de los datos mostró un perfil socioeconómico de baja escolaridad, subempleos y salarios bajos, así como la deficiencia de infraestructura urbana y acceso a servicios urbanos y de entretenimiento. Además, se constató la dificultad de percibir el medio físico de los locales habitados, así como los riesgos inherentes a los impactos que existen en los mismos, como por ejemplo las cárcavas. Eso demuestra la necesidad inminente de ordenamiento gubernamental sobre el uso del suelo y sobre la educación ambiental formal e informal que permitan la efectivización de acciones preventivas de procesos erosivos lineares.

Palabras clave: Cárcava, suelo, medio ambiente.

Introduction

Discussing soil erosion with experts from various fields of knowledge produces equally varying perceptions, given that each will privilege the conceptual and pragmatic guidelines of his/her specific theoretical training. What brings these professionals together is the study of the causes of erosional processes, even though many will often seek such causes, isolatedly, in the environmental context. In addition, among those who seek solutions, these are not always linked to environmentally contextualized causes. Certain professional categories warrant particular distinction regarding research on erosion: agronomists, geotechnical engineers, geographers, geologists, and public administrators (mayors, governors).

What about an individual living on the edge of erosion? Under what circumstances is he/she considered when the causes of this process are analysed? Where does he/she fit in in studies which examine the consequences of such a process? Above all, when is he/she considered in the act of selecting the most appropriate solutions for a given location? How may his/her quality of life be affected by the dynamics of erosion?

It is safe to say that few technical professionals have focused on what a person who lives around an eroding area or who lived in a place wiped out by erosion thinks about this hazard. Therefore, in order to address the population living around linear erosion areas i.e. gullies, this study sought to examine who these people are, how they relate to erosion, and how the latter interferes in their quality of life. After all, according to Bertoni and Lombardi Neto (1999), erosion is as much a

socio-economic problem as a technical one, given that achieving success through soil conservation measures depends on a set of social and economic implications.

This study did not intend to bring forth quality of life indexes, but instead to discuss the many indicators associated with this concept. Hence it presents a new possibility of addressing accelerated erosion processes whose social causes and outcomes are generally superficialized and glossed over by concerns strictly linked to the physical phenomenon held by geologists, engineers, and geographers, or by public management's short-sighted concerns. Individuals who live around eroding areas are not only a number in population statistics; they have life stories, feelings, and needs which make them subject themselves to the risky environment of erosion, becoming exposed to all sorts of hazards that go beyond accidents involving property damages, as will be shown in the following sections (Figure 1).



Figure 1 - In the foreground, slope of the gully known as Cidade Jardim; in the background, one of several houses located close to the gully.

Source: Jesus (2013).

Methodology

In the urban area of Anápolis, Goiás state, seven incisions of gully erosion were selected for a more detailed analysis (Figure 2). They are representative of the geomorphological compartments within which

they are located; four of them can be found in the eastern portion of the research area, where dissection and declivities are less pronounced, while the other three are located in the western portion, where there is considerable dissection and high declivities. Selecting the gullies also took into account incision typology; hence two slope gullies, one drainage gully, and four headwater gullies were selected. The gullies, or *voçorocas*, were given the following names in the present study: Voçoroca Túnel (VT), Voçoroca Contorno (VC), Voçoroca Geovane Braga (VGB), Voçoroca Cidade Jardim (VCJ), Voçoroca Colégio Estadual (VCE), Voçoroca Leopoldo de Bulhões (VLB), and Voçoroca Frei Eustáquio (VFE).

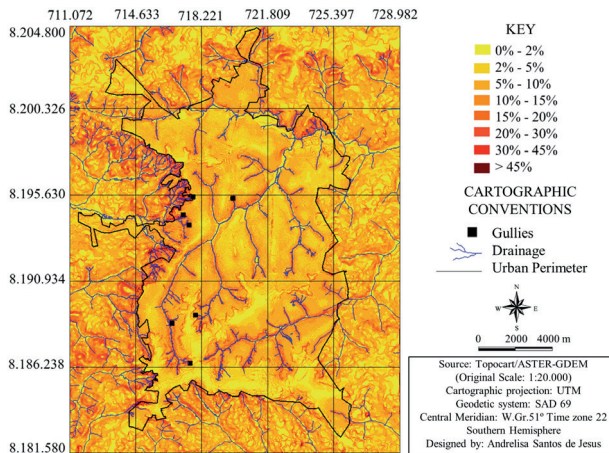
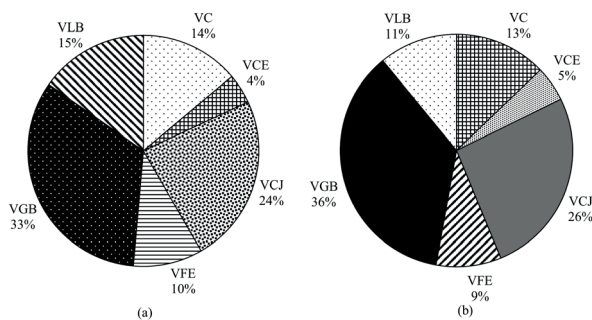


Figure 2 - Declivity map of the urban and peri-urban area of Anápolis, Goiás state, showing the gullies analysed by the present study.

In 2012, interviews were carried out with individuals who live around the erosion. The methodology used to produce the interview guide was based on the work by Jesus (2007), who spoke to residents of the upper Das Antas river basin in Anápolis guided by the same objective as that of the present research. Moreover, the questions which made up the interview guide were also based on the work by Coelho (2001), including fields which refer to the population's socio-economic standings. It should be noted that the interview guide used in this study addresses the issues covered by the environment domain as proposed by the World Health Organization (WHO).

The interview guide included indicators on education, professional status, profitability, background, living conditions, urban infrastructure, available services, access to leisure and information, perception of place of residence, and sociopolitical collaboration. Interviews were carried out in 72 houses, and in each of them an adult representative spoke to the interviewer, providing him/her with information on all the other residents. Therefore, interviews produced information regarding 264 people in total. The number of houses covered by the interviews was not the same for all erosion incisions (Graph 1). Access to houses depended on several factors, e.g. residents' presence, availability, and permission to take part in the research, extent of erosion, and number of houses close to the erosion. No interviews were carried out in the vicinities of VT due to the fact that it is located in an area outside urban occupation, hence there are no houses in its surroundings.

The qualitative nature of the research is thus evident in the way it sought to transcend the static coolness of numbers, percentages, and questionnaires linked to most of the collected data, hence shedding light on residents' needs. After all, these individuals are often only remembered in occasional headlines of tragic events which brand their lives deeply and irrevocably. This qualitative nature follows the basic principles adopted by Jesus (2007) and Jesus, Lopes, and Carvalho (2009), the latter being a similar study though restricted to the upper Das Antas river basin in Anápolis, where the most important and valuable element perceived by researchers was residents' feelings.

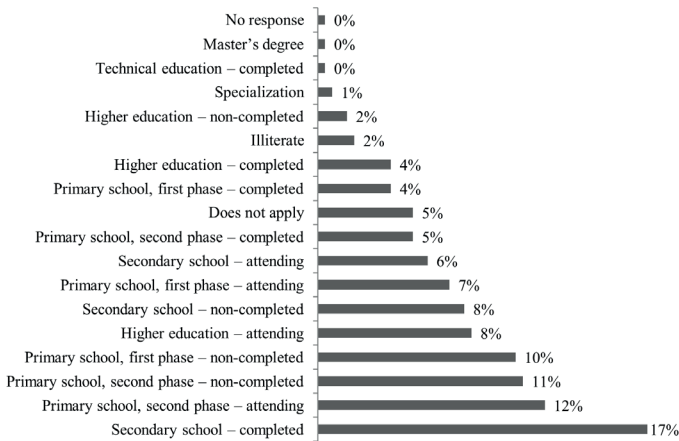


Graph 1 - Interview sampling: (a) distribution of houses surveyed per gully; (b) distribution of interviewees per gully.

Source: Jesus (2013).

Results and discussion

Among the interviewed residents, 24% were attending primary school and 37% had not completed it. In addition, 17% of interviewees who completed primary school did not pursue higher education. Only 14% reached that level of education (Graph 2).

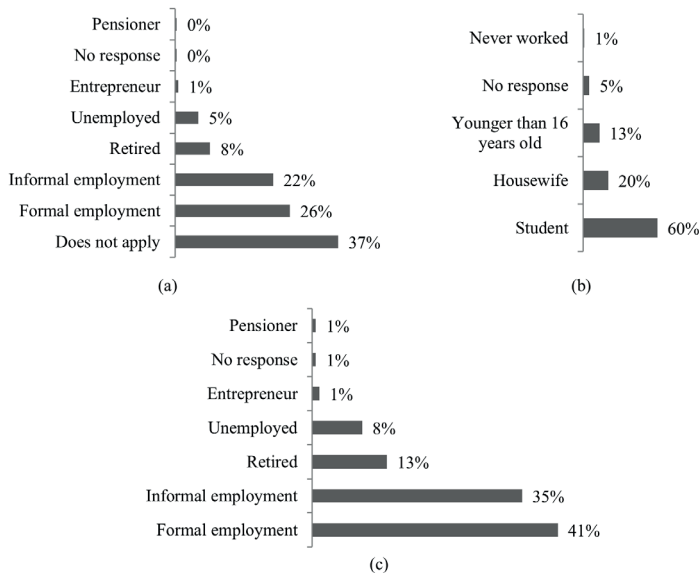


Graph 2 - Educational levels of individuals living around eroding areas.

Source: Jesus (2013).

As regards residents' employment status, the research took into account the legal minimum working age in Brazil, i.e. 16 years of age, in accordance with constitutional amendment number 20, passed on December 16, 1998. Therefore, 37% of residents were grouped in the "does not apply" class (Graph 3a). In fact, within this percentage are 5% of individuals who did not inform their working status, 1% who declared never having worked before, 13% who were under 16 years of age, 20% who were housewives, and 60% who were students (Graph 3b).

As for the working residents, 41% reported being formally employed, whereas a significant 35% reported being informally employed. Moreover, 8% of residents were then unemployed, of which the large majority, 47%, declared having been unemployed for less than six months up to the date of the survey, while 27% declared having been unemployed for two years (Graph 3c).



Graph 3 – Residents' working data: (a) employment status at the time of the research; (b) specification where employment status does not apply; (c) working population.

Source: Jesus (2013).

The high percentage of informal employment may be directly linked to residents' educational level, most of whom failed to complete primary school. This scenario highlights the existence of a non-qualified workforce, generally a major factor in terms of entry into formal employment and, consequently, access to adequate income. A similar finding was verified by Jesus (2007) and Jesus, Lopes, and Carvalho (2009) in the upper Das Antas river basin, where the combination of low educational levels and informal employment resulted in very low income.

The analysis of residents' income took into account the minimum wage rate of R\$ 622,00 (in Brazilian reais), established on January 1, 2012 in accordance with decree number 7,655 (Brasil, 2011). Among the employed interviewees, the vast majority, or 64%, earned a minimum wage or two times a minimum wage. Considering the family income, i.e. the sum of earnings by all its members, the research showed that most families, or 52%, live with earnings ranging from one to two times the minimum wage.

Residents' low income, according to the current research, confirms a reality already outlined by Instituto Brasileiro de Geografia e Estatística (IBGE), the Brazilian Institute for Geography and Statistics, in 2010: the fact that 39% of families in Anápolis earn up to two times the minimum wage. This percentage increases to 78% if one considers income of up to five times the minimum wage. Such a low family income is acknowledged by Anápolis' municipal government through its master plan report (Anápolis, 2006).

The triad low educational level/informal employment/low income may induce and sustain an indicator of social marginalization, particularly as far as housing is concerned. According to Santos (2008, p. 144, our translation),

“[...] a family whose income is up to three or four times the minimum wage is only able to obtain housing, whether their own property or a rented one, with some sort of combination of the following variables: distance, hazardness, insalubrity, environmental discomfort, constructive precariousness, and land irregularity”.

As regards the reasons for choosing the present neighbourhood to live in, 36% of interviewees declared that their main reason for moving was access to housing, of which 29% and 7%, respectively, referred to home ownership and affordable rent. Despite its proximity to the erosion, the settlement's location also enjoys a relevant percentage (21%) among residents' reasons for choosing to live in the area.

The reason why location ranks among the main factors for residents' decision to live in the area is that most of the neighbourhoods involved are close to the city centre, which, in the specific case of Anápolis, still concentrates a considerable number of commercial establishments and services. As for more distant neighbourhoods, location remains a relevant factor because it often brings residents closer to their workplace; this is the case of neighbourhoods Geovane Braga and Polocentro, located next to the Distrito Agroindustrial de Anápolis (DAIA), Anápolis' Agroindustrial District. These specificities show the importance of quality features in a city's master plan, which must be grounded on preliminary studies regarding the limits of land use and occupation so as to prioritize socio-environmental issues.

The vast majority of residents, i.e. 61% lived in their own homes, whereas 39% lived in rented properties. Of the latter, 53% paid rent wages

ranging from R\$ 250,00 to R\$ 622,00, and 36% paid wages up to R\$ 250,00. By associating profitability with the cost of rent, one may conclude that housing expenses considerably affect these families' income, since in most cases it does not exceed two times the minimum wage. In some cases the cost of rent may take up half of the family income. Therefore, according to Carlos (2001, p. 79, our translation), an individual "lives where he can afford to and this will be determined by his/her income and by the sacrifices he/she can make." As far as this study's interviewees are concerned, they can live and afford to live close to erosional incisions.

As regards the infrastructure of the area in question, most houses benefit from street lighting, water supply network, storm water drainage, and asphalt pavement. However, only 24% of the houses are served by sewage systems, whereas a staggering 75% use septic tanks for waste disposal.

Evacuation through storm water drainage is often inappropriate, whether in terms of disposal conditions which result in erosion, or in terms of the volume collected and thrown into thalwegs and watercourses, which leads to downstream floods.

Even though a staggering 96% of interviewees declared they had access to rubbish collection, around 6% throw rubbish into the erosion or discard it inappropriately by placing rubbish bags directly onto the sidewalk. Among those whose rubbish is not collected, it is discarded into the erosion or into vacant lots.

As for security, 58% of residents did not view the place they live in as violent, but most failed to justify their opinion. On the other hand, the 42% of interviewees who consider the area violent justified their answer by evoking episodes of robbery and theft, drugs and killings (37%, 35%, and 12%, respectively).

It should be pointed out that the factor "drugs" stems from our interpretation of interviewees' references to drug use/consumption and trafficking. Moreover, the majority of residents mentioned eroding areas or their vicinities as sites for several crimes, such as killings and drug use and trafficking.

As regards health, the analysis showed that 19% of interviewees were never called on by health care and/or sanitary agents. As for medical care, 66% of residents are treated by Brazil's unified health system, the Sistema Único de Saúde (SUS); of these, the majority declared they are

given standard medical care, while a significant 18% claimed they are poorly treated.

As far as public transport is concerned, 68% of interviewees consider it effective and accessible. Virtually half of the residents used this service, taking one or two buses on average to reach their intended destination. Around 23% of residents have a car and 5% have a motorbike. Among those who have their own means of transportation, public transport is not an option.

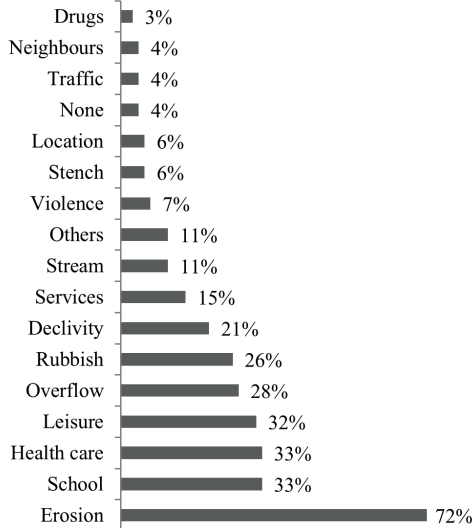
When asked which leisure activities they engage in in their free time, interviewees mentioned several, with a high number of references being made to church and television as sources of leisure; the former was mentioned by 61% of residents and the latter by an impressive 46%.

With regards to the advantages of living in the area, tranquility and location were the top-ranking factors in the survey. Given that 42% of interviewees considered the neighbourhood violent, the fact that tranquility comes up as the main advantage of the neighbourhoods assessed may seem contradictory. However, such a contradiction is only superficial, for residents' perception of tranquility is linked to several parameters other than violence. Interviewees mentioned neighbourly relations, proximity to relatives, home ownership, affordable price of rent, and even the fact that these locations offer greater traffic-related tranquility, lower noise level, and often greater interaction with natural environments.

As for disadvantages, erosion was elected by 72% of interviewees as an element that interferes negatively with the daily routine of local residents (Graph 4). School, healthcare, and leisure were also mentioned by many of the residents, hence exposing a shortage of equipment and services related to these factors. Seventy-four per cent of answers included some sort of damage faced by residents.

According to residents' reports on damages caused by erosional incisions, stench was pointed out by 18% of respondents. It is a kind of invisible and silent pollution whose magnitude cannot be conveyed through photographs or videos. When a gully is said to cause visual impact and a person is given a photo of it to look at, that person will possibly feel shocked both at the photo and at a live image of the phenomenon, a not possible reaction as far as stench is concerned. For someone to understand its level of impact, it is necessary to experience it. Nevertheless, neither

ravines nor gullies exhale smells by themselves, be them pleasant or not. Stench is not caused by erosion, but by the rubbish and occasionally the water used by the population – not necessarily local – and then thrown into the incisions. Hence erosion may contribute to the emergence of yet another environmental impact that directly interferes with quality of life and public health: stench.



Graph 4 – Disadvantages of living in the eroding area.

Source: Jesus (2013).

The presence of insects was also appointed as an erosion-related hazard by 14% of respondents. In general, the very same rubbish discarded into erosional incisions and which causes the stench when decomposing also favours the proliferation of insects such as cockroaches, flies, and mosquitoes. Moreover, six per cent of residents mentioned the presence of rodents such as mice. Poisonous animals like scorpions and snakes were also reported by some of the residents since they find easy shelter among the rubble and the tall grass within incisions. It is worth mentioning that the rubbish found in the area also contributes to the rise of breeding sites for mosquitoes (*Aedes Aegypti*) which transmit the dengue virus, and 6% of residents declared that the existence of disease carriers was an erosion-related hazard.

Risk to children was pointed out by 4% of respondents and must be taken into consideration, given that 20% of the population addressed by this research is aged between 0 and 14 years. Such a risk ranges from contamination to falls and cuts or puncture wounds from sharp objects found in incisions.

In view of all the difficulties associated with erosion and the problems stemming from its evolutionary dynamics, it was surprising to find that 61% of interviewees answered “no” when asked whether they would like to move from the area. However, 52% of these respondents did not specify the reason for wishing to remain in the neighbourhood. Those that justified their desire to stay mentioned the following factors: preference for the location, neighbours, access to services, absence of danger for the house, recovery of eroded area. Tranquility and home ownership were the most popular reasons for wishing to remain in the area, each having been elected by 9% of respondents.

The research also revealed a lack of knowledge on the part of residents regarding the hazards and risks to which they are exposed in the presence of erosion. In some houses the interviewees did not even have a backyard, swallowed by the advancing erosion, and still they declared the phenomenon caused no hazards. Erosion becomes a part of people’s daily lives, much in the same way as the street, the house, the neighbours (Figure 3). We may also consider that not acknowledging the risk inherent to erosional incisions may be an unconscious act on the part of residents in view of a relentlessly cruel reality, in other words, the only way they are able to sleep under such risky conditions every night is to ignore the problem.

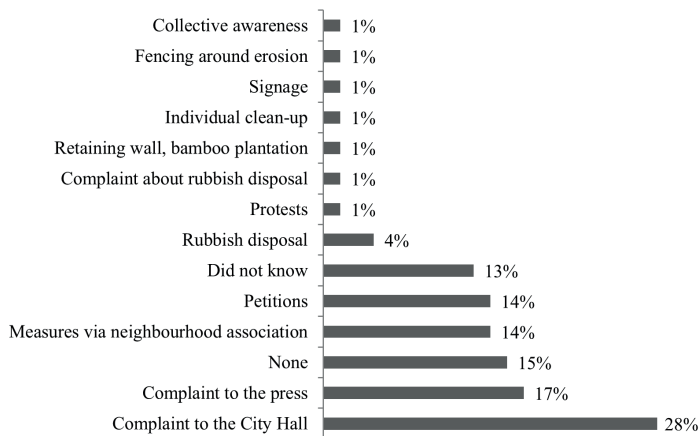
Figure 3 shows such a relationship between residents and erosion. A family of eleven, five of them children, was photographed in one of the gullies included in the research, posing for the camera as if standing in front of their home or in the local square. These people ignore the risks to their physical integrity and health posed by possible landslides and soil contamination caused by waste.



Figure 3 - Family photographed in a gully located in Anápolis.

Source: Jesus, 2013 (photo from family collection, freely given to researchers during the interview phase). Faces were concealed in order to preserve individuals' identities.

To verify residents' sociopolitical collaboration in relation to their daily reality of living alongside erosion, they were asked what they and their neighbours had done to solve the problem (Graph 5). Several measures were mentioned, but interestingly 15% of respondents claimed never having acted and 13% declared they knew nothing about such measures.



Graph 5 - Measures taken by residents to solve the problem of erosion.

Source: Source: Jesus (2013).

The most popular measures among residents consisted of complaining to the city hall (28% of respondents) and complaining to the press (17% of respondents). Measures via neighbourhood association president/chair and petitions were each pointed out by 14% of interviewees. Further measures were brought forth, but by a small group of residents. Hence, it came through that residents established little cooperation among themselves. Most of them never took any steps to solve the problems caused by erosion, and among those who did attempt to take action, initiatives were often isolated, without involving the whole neighbourhood. Some of the residents are not even aware of the existence of the neighbourhood association or know its president.

Final considerations

Following the interviews carried out with the local population, the research showed that environmental damages caused by linear erosion processes, i.e. gullies, affect quality of life and pose threats to people's health and even lives, a scenario which demands preventive – and, in some cases, mitigating – measures on the part of public authorities.

It is crucial that the various professionals working with erosional processes perceive this phenomenon in a broader and integrating sense, so as to foster citizenship and dignity for those who live close to eroding areas. Public managers, for instance, should view erosion as much more than an administrative problem – it is also a problem of public safety, social inequality, education, and public health.

Such a role to be played by public management should begin with the drafting of the master plan and continue with the establishment of suitable norms for land occupation and use that regulate even the implementation of basic infrastructural work. For such norms to become effective, it is necessary to intensify actions which provide formal and non-formal environmental education for the population as well as to encourage enforcement, keeping in mind that the task of educating prevents future damages.

Providing education that fosters awareness of the spatial reality in which one lives enables, above all, the practice of citizenship, since it offers possibilities for a person or group of people to intervene in and modify their reality. Alienation towards one's living space can sometimes

aggravate the situation of residents who are directly and deeply affected by the natural phenomenon at hand – with used-up water and rubbish being thrown in and around incisions –, as well as hinder collaboration intent on solving the problem and/or put pressure on public authorities so they can mitigate it.

Such a scenario stems from residents' lack of knowledge regarding the space they live in, the risks they are exposed to, and their rights as citizens. Therefore, quality of life has a direct relation with knowledge of living spaces. This warrants the need for environmental education for the city and the space. This lack of knowledge does not appear to be an issue of social class or education, for we observed over the course of the research that many people know nothing about the relief or the hydrography of the landscape they live in.

Educational measures that enable residents to know more about the space they live in as well as about geology, terrain, hydrography, and the land are, in summary, of crucial importance. This localized, regionalized knowledge of the living space allows residents to establish greater intimacy with the place they live in, with their city, as well as greater awareness of occupation-related risks in more environmentally sensitive areas. Therefore, such spatial and environmental awareness tends to be reflected in people's daily actions, e.g. by becoming aware of properties that disregard environmental issues, by respecting the permeable areas of every backyard or even by refraining from throwing rubbish into gullies. These and many other measures may prevent and mitigate erosional processes and other forms of land degradation and environmental impact.

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Author contribution in the development of the paper:

The authors collectively provided the study with scientific and intellectual contributions. The first author performed the collection, tabulation, data analysis, and initial preparation of the manuscript. The second author collaborated with the discussion of the results offering substantial contributions regarding the interpretation of the data.

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