

ANTHROPOGENIC INDUCED PROCESSES IN URBANIZED ENVIRONMENTS

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Abstract

Anthropogenic Geomorphology is characterized as a branch of geomorphological science that considers anthropic actions as relief modifying agents. This approach is currently presented as a fundamental tool in the analysis of geomorphological and hydrogeomorphological processes occurring in urbanized areas, because such locations have gone through and are going through significant changes triggered by actions of anthropic origin. Therefore, it is necessary the existence of a conceptual construction that contemplates the geomorphological processes from an anthropogenic approach. It is in this context that this article aims to enunciate the concept of anthropogenic induced processes, theoretically presenting its conceptual distinction against geomorphological natural / spontaneous processes and indicating its applicability in the analysis and interpretation of geomorphological phenomena triggered in urbanized areas.

Keywords: Anthropogenic Geomorphology; Anthropogenic Induced Processes; Urbanized Areas.

Resumo / Resumen

PROCESSOS ANTROPOGÊNICOS INDUZIDOS EM AMBIENTES URBANIZADOS

A Geomorfologia Antropogênica se caracteriza como um ramo da ciência geomorfológica que considera as ações antrópicas como agentes modificadores do relevo. Tal abordagem se apresenta atualmente como uma ferramenta fundamental na análise dos processos geomorfológicos e hidrogeomorfológicos ocorrentes em áreas urbanizadas, haja visto que tais localidades passaram e passam por significativas alterações desencadeadas por ações de origem antrópica. Logo, se faz necessária a existência de uma construção conceitual que contemple os processos geomorfológicos a partir de uma abordagem antropogênica. É nesse contexto que o presente artigo objetiva enunciar o conceito de processos antropogênicos induzidos, apresentando de maneira teórica sua distinção conceitual frente aos processos geomorfológicos naturais / espontâneos e indicando sua aplicabilidade na análise e interpretação dos fenômenos geomorfológicos desencadeados em áreas urbanizadas.

Palavras-chave: Geomorfologia Antropogênica; Processos Antropogênicos Induzidos; Áreas Urbanizadas.

PROCESOS ANTROPOGÊNICOS INDUCIDOS EN AMBIENTES URBANIZADOS

La Geomorfología Antropogénica se caracteriza como una rama de la ciencia geomorfológica que considera las acciones antrópicas como agentes modificadores del relieve. Este enfoque se presenta en la actualidad como una herramienta fundamental en el análisis de los procesos geomorfológicos e hidrogeomorfológicos que ocurren en las áreas urbanizadas, dado que dichas localidades han sufrido y están experimentando importantes cambios desencadenados por acciones de origen antrópico. Por tanto, es necesaria la existencia de una construcción conceptual que contemple los procesos geomorfológicos desde un enfoque antropogénico. Es en este contexto que este artículo tiene como objetivo enunciar el concepto de procesos antropogénicos inducidos, presentando teóricamente su distinción conceptual de los procesos geomorfológicos naturales/espontáneos e indicando su aplicabilidad en el análisis e interpretación de los fenómenos geomorfológicos desencadenados en áreas urbanizadas.

Palabras-clave: Geomorfología Antropogénica; Procesos Antropogénicos Inducidos; Áreas Urbanizadas

INTRODUCTION

There are many definitions regarding the object of study of Geography. Moraes (1994) presents one of the first concepts attributed to Geography, which entitled it as an area of knowledge destined to the study of the earth's surface. It is necessary to take into account that this concept dates from the middle of the 19th century, where the link between geographic science and actions related to the description of the natural aspects of the Earth's surface was in force. This relationship was largely influenced by the Kantian view linked to Geography studies at the time.

Milton Santos defines geographic space as an object of study in Geography, taking into account its analytical categories such as the social space (SANTOS, 1986, p. 116). This social space takes as a backdrop the locality in which human relations are developed as presented by Saquet and Silva (2008):

“Social space corresponds to human space, a place of life and work: Man's home, without fixed definitions. Geographical space is organized by Man living in society and each society, historically, produces its space as a place of its own reproduction.”

The geographic space, like the social space, are concepts that define a dynamic of actions developed by society, so it should be noted that these actions are carried out in a concrete place, which is the earth's surface, that is, the relief. Seeking to understand the process of appropriation of relief by man and its implications, it is necessary to make an effort to seek to go beyond what is conceptually set and to foster debate on this theme. It is in this context of space, where Man and environment interact in a dynamic way, that the present work seeks to carry out the study of the geomorphological characteristics, from an approach that places this Man as a being that integrates and transforms the surface of the relief. According to Cassetti (1995), dissociating the human factor from the natural is inappropriate when one intends to develop a study on the landscape, since the production of space takes place exactly from this interaction.

It is worth remembering that when discussing the different geographic stratus that make up the geosystemic approach, Penteado (1981) presents the concept of anthroposphere, as the contact surface where “Man aggresses, corrects and makes natural systems economically productive [...]”. Therefore, it is possible to indicate the existence of an understanding, where Man is not just a component of this geographic stratus, but a transforming agent of it, occupying a prominent position in the dynamics that condition the flows of energy and matter occurring there. The term “aggresses” can have different interpretations, but in the field of geomorphology, it is not difficult to link such an expression to the processes of disaggregation and accumulation of relief formation.

That is, when it is indicated that Man “aggresses” the relief, it is possible to interpret such action as an alteration / modification of that surface. However, it is necessary to point out that this interpretation does not place Man in the role of sculptor as in an artistic process, changing landforms and creating the perfect work of art. Because the relief has its own balanced dynamics, governed by the flows of energy and matter, which once altered will cause reflections that will be noticed and may impact the populations that inhabit this social space that is the surface of the relief.

Ross (2001) presents the relationship developed between man and the inhabited space, when he poetically defines the Earth's relief as being “an important part of the stage, where Man, as a social actor, practices the theater of life”. Previously to him, De Martonne (1964) had also exposed his idea where, “the Earth's relief assumed expression as a resource or support of life, the stage of the development of history”. These concepts not only contextualize the idea already presented regarding the social space, but also reinforce that Man is indeed present and active in the alterations of landforms.

Interactions involving relief and urban development have been known for centuries (CSIMA, 2010). Historically, the analysis of the landscape and, consequently, the relief, was one of the main factors taken into account when trying to carry out the implantation of a certain urban site. However, it is necessary to emphasize that this analysis did not start from a scientific approach, or even linked to urban planning for orderly occupation of this landscape. This analysis was based on meeting basic needs, such as access to water for human consumption or for irrigation of plantations, implementation of roads due to the less busy terrain conditions, among other factors.

It should be noted that some of the main urban sites around the world began their process of urban development in the Middle Ages (5th to 15th centuries) on the banks of large rivers, such as Paris on the banks of the Seine River, or Berlin and London, which expanded along the banks of the rivers Spree and Thames. Another important ancient city was Ur (4000 BC), which was a prominent Sumerian city-state (present-day Tell el-Muqayyar, Iraq), located in the Euphrates River Valley that, along with the Tigris River made up the region of Mesopotamia, the site of implantation and expansion of the main urban settlements of the time, widely indicated as the cradle of civilization (ROUX, 2002; KRIWACZEK, 2018).

However, this aforementioned strategic thinking should not be confused with what we understand today by Urban Planning, because as mentioned above, the ideas adopted sought to meet specific and essential points for the populations of the time. However, the existence of a longevous relation between natural landscapes and their transformation by human populations is undeniable.

It is worth remembering that the development of urban populations and their expansion across the relief surface is not something static in time and space, a fact that has provided extremely complex scenarios with regard to urbanized landscapes. So that it is possible to find the most diverse patterns of occupation, ranging from countless cities that developed on the coasts of continents, to occupations located at high altitudes, like La Paz, an urban agglomeration with approximately 2 million inhabitants in its metropolitan area, forming a true urban enclave, located in a wide valley in the Andes Mountains at an altitude of over 3,600 meters. And as a point of contrast, it is possible to mention several urban sites that developed below sea level, highlighting most of the Dutch municipalities, since 60% of the population of Netherlands sides in areas located topographically in this condition.

And what about the Palm Islands, an artificial archipelago built in Dubai, in the United Arab Emirates, made up of approximately 100 million cubic meters of sand. A place where there is currently a huge range of infrastructure, consisting of buildings, streets and a series of other housing and tourism properties that house a population of approximately 80 thousand people.

That is, it is possible to reach the point where urban agglomerations around the world had their beginning linked to a certain dynamic, which, over the years, was not “abandoned”, but modified, undergoing several transformations related to each historical period and the interests of the time, interests which may have been economic, political, or planning.

The concern about the development of cities in the landscape has always been the scope of Urban Geography, which seeks to find means that make it possible for a certain action (urban expansion work) not to cause negative impacts of great intensity in the urban environment. Among these impacts are changes in the dynamics of the physical environment, where such urban changes can trigger changes in the hydrological, geomorphological and hydrogeomorphological behavior of such a location, causing several problems that will directly impact the action / work that is intended to be developed, in addition to other areas consolidated areas of this urban agglomerate and their respective populations. Therefore, carrying out an analysis of how the development of cities impacts landscapes and their components is a point of great relevance. Based on this assumption, the present study proposes to analyze one of the components of this altered landscape, which is the relief, paying direct attention to its dynamics and its transforming agents.

In Brazil there are countless examples of cities that grew in a disorderly way and currently face a series of difficulties due to this fact. The population increase that has occurred since the 1970s, linked to the migration of populations from the countryside to the cities, has given rise to huge and disorderly urban agglomerations. This large population contingent modified the structure of cities, making them acquire greater size in a relatively short period of time, a fact that often made it difficult for actions related to urban planning to be carried out and applied effectively.

There are many reflections that can be noticed in large brazilian metropolises such as São Paulo, Rio de Janeiro, Salvador, Belo Horizonte, among others. Several are impacted by urban floods due to factors such as the high rate of waterproofing of urban soils, which hinders the natural process of drainage and infiltration of rainwater; in addition to the rectification and channeling of channels without the proper study of the impacts that this alteration would have on the hydrogeomorphological dynamics of the watercourse (TUCCI, 2016).

Nonetheless this series of occurrences is not exclusive to large urban centers, as some

medium-sized cities already face difficulties related to the aforementioned impacts, as is the case of Joinville (SC), and Petrópolis (RJ), as presented in the studies by Silveira et al. (2009) and Santos (2007) respectively.

When we deal with environmental impacts, there are many examples associated with urban evolution. Using the municipality of Uberlândia, Minas Gerais as a reference, it is possible to list facts related to urban flooding, mainly generated by the high soil waterproofing associated with the deficient system of storm sewers existing in the municipality (PEDROSA et al., 2016). Added to this is the existence of canalization of rivers/streams; occupation of river valleys; silting up of watercourses and springs; erosive processes in drainage headwaters; gullies associated with capturing urban drainage, among others.

Given the existence of this series of facts, which should be explored by the academia, this article will bring the classification of anthropogenic induced processes for urbanized environments, aiming to conceptually present the geomorphological and hydrogeomorphological processes that are directly affected by anthropic actions and their structures.

THE INSERTION OF THE CONCEPT IN THE GEOMORPHOLOGICAL SCIENCE

When aiming for a certain scientific concept to be well understood, it is necessary initially that its structure be understood, in this sense, fundamental points will be presented, which were used in the elaboration of the concept in question. Seeking in this way to lead the reader through the path that culminated in the construction of what is understood by, “Anthropogenic induced processes”, in urbanized environments.

Initially, it was necessary that the geomorphological processes addressed were related to two scientific branches that would give them the theoretical framework for their development. The fields in question are Geomorphology and Hydrogeomorphology. As for the scientific philosophical clashes that permeate the understanding of Hydrogeomorphology as an applied science, these will not be discussed at this time as they are not the main focus of this work. Therefore, it should be noted that Goerl et al. (2012), states that the object of study of Hydrogeomorphology are the hydrogeomorphological processes. Because, when defining your study object, hydrogeomorphological studies are analyzed at a different way, emphasizing whether or not they meet the object, regardless of the method used (SCHEIDEGGER, 1973; RICHARDS, 1988). It is from this reading that in the present work Hydrogeomorphology is used to give scope to the processes of urban flooding, the floods and high diffusion runoff, since the same are inserted in the scope of the thematic.

This decision is based on several studies in which floods and high diffusion runoff are analyzed from a hydrogeomorphological perspective, analyzing the development and characteristics of the processes in question (EVANS et al., 2001; MONTGOMERY e BOLTON, 2003; WILFORD et al., 2004; SAKALS et al., 2006). On the other hand, we can mention Goudie (2004), that defines Hydrogeomorphology as the interface between geomorphological and hydrological knowledge, being part of the field of geomorphological science, which can be defined as “Hydrological Geomorphology”. This fact makes us return to the thought of Goerl et al. (2012), reaffirming that the processes in question act on the interface Geomorphology / Hydrology, and having this understanding, there is no reason to engage in discussions that are disconnected from the proposed theme and that would not bring a significant contribution to the understanding and development of Anthropogenic induced processes.

Dealing with processes under the aegis of Geomorphology, are included in the study, the ravines, piping formation, gullies (deep incisions), riverbank erosion, and the silting up of urban fluvial channels. These processes have already been widely discussed in the scientific community, tendo sua gênese e desenvolvimento analisados a partir das mais diversas abordagens e métodos. However, there are still points to be discussed about them. And when the analysis of these geomorphological processes is proposed from a reading primarily linked to Anthropogenic Geomorphology, it is seen that there is a vast field to be explored.

THE UNDERSTANDING OF MAN AS A TRANSFORMING AGENT OF LANDFORMS

Brown (2017) states that in Geomorphology and Geology, studies that considered human actions as part of the processes related to them began in the 19th century, highlighting the studies of Marsh (1874) and Gilbert (1877). In view of this, it is necessary to highlight the work *Principles of Geology* by Charles Lyell published in three volumes between the years 1830 and 1833, presented by Pelóggia (2005), where it is stated that the author (Lyell) even if indirectly already pointed out a certain relevance of the human interference on the relief surface, exposing examples such as draining swampy areas and lakes for the implantation and consolidation of anthropized structures, like urban sites. When Lyell discusses the existence of an anthropic agent, he does so from a geological point of view, inherent to the origin of his educational background. However, this fact actually minimizes anthropic actions when juxtaposed with natural mechanisms, given the example of the Mesozoic spills mentioned in his work, thus necessitating a reflection on the application of the guiding concept to be used in debates related to anthropogenic actions.

When dealing with anthropogenic processes in Geomorphology, it is impossible to neglect the work of Andrew S. Goudie, who was one of the pioneers in considering human actions as relief modifying agents. The author places Man as responsible for playing an active role in the creation of landforms, as well as in geomorphological processes, such as the cycle of the erosion process. Goudie (2013) emphasizes attention to anthropic interferences that act indirectly with geomorphological processes, which in turn are not easily identified, as they often trigger disturbances / changes in the natural dynamics of these processes, which can, for example, drastically increase the sediment load that reaches a river channel, causing its precocious silting up in an anomalous way.

Pelóggia (2005) makes it clear that there is a certain convergence in the positions of Lyell and Goudie, given that both present in their explanations the existence and importance of Man as a transforming agent of the Earth's surface. However, both, but essentially Lyell, seek to emphasize a supporting role for the human being in the face of the exponential magnitude of natural processes, indicating that anthropic modifications, although important, would be "insignificant" when compared to the great global geological processes. This placement sounds somewhat obvious, when referring to the dimension of the aforementioned basaltic spills from the Mesozoic, which occurred in the southern hemisphere of the ancient continent Gondwana, which could be noticed in the areas today represented by India, South Africa and the South American continent, having its coverage area estimated at around 2 million square kilometers (LEINZ, 1949).

However, it is up to researchers who seek to work on such themes, to use the classics as compasses in the search for their understanding, but without stifling the opportunity for counterpoint and debate. And in this context it is necessary to point out that although safeguarding the fair proportion between anthropic and natural processes, we must emphasize that the relevance of Man as a transforming agent of the landscape, has undergone a significant increase over the last 200 years. At this point, it may be necessary to carry out a literal conceptual distinction, which sometimes constitutes a certain difficulty in the development of some reasoning, and here we refer to the fact of placing Man (human activities) as a transforming agent of relief. Making the conceptual diversity that runs through some scientific branches not difficult to understand the relevance of Man in the transforming processes of the Earth's surface.

It is important to point out that some concepts, such as some of those mentioned above, began to be worked on with greater emphasis in the final decades of the 19th and beginning of the 20th century, a fact that corroborates the understanding of why they were not discussed with the utmost attention. clarity in works from the beginning of this period, since they were still being debated and undergoing a maturation process in terms of their understanding. However, the course of decades of debates and research carried out allows us to use them with the necessary theoretical-conceptual rigor, so that in this way the developed discussions can be supported in the best possible way.

Seeking to fill this conceptual gap, left by the accelerated pace of changes that occur in landscapes modified by anthropic agents, the class of Anthropogenic Induced Processes was thought of (Fig. 1). This nomenclature encompasses the processes (geomorphological and hydrogeomorphological) involved

in the abrupt alterations of natural and built landscapes. Therefore, it is understood by Induced Anthropogenic Processes, the geomorphological and hydrogeomorphological processes, which are likely to be directly related to anthropic actions and their structures, which have been the initial or preponderant mechanism for their occurrence or aggravation.

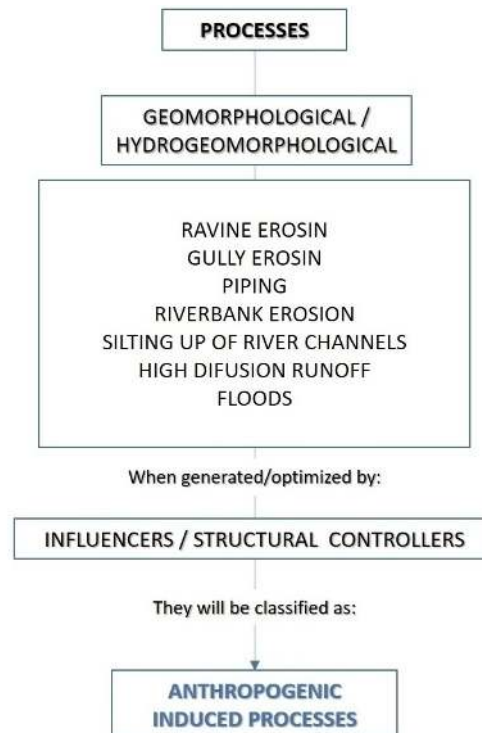


Figure 1 - Classification of Anthropogenic Induced Processes.

At this point, we will not stick directly to the morphology of the urban relief, but rather to the understanding of the processes that modify it. Emphasizing that most of the geomorphological processes occurring in urban areas currently do not leave significant evidence after their occurrence, except for events of great magnitude, example of landslides of large proportions or the appearance of craters from the collapse of the soil related to regional karst characteristics or directly by excavation works that led to the removal of the material that attributed stability to this superficial layer of the soil.

And when it is said that medium and low intensity processes do not leave significant records of their occurrence in the landscape, this is not due to their smoothness, but rather to the fact that, once modified by these processes, the urban environment tends to pass the as soon as possible by engineering works that seek to return to that location impacted by the process, its previous characteristics. That is, in the place where there was a high diffusion runoff that generated the appearance of a ravine on a public road, or a collapse of the soil due to the existence of an anthropogenic process of piping in the subsoil that caused the appearance of a crater on that same road, engineering works tend to be carried out as quickly as possible, which in most cases will seek, even if without long-term effectiveness, “to take palliative measures”. Where, as a rule, the grounding of said features will be carried out so that it is possible to recompose the asphalt layer and restore the flow of vehicles in the impacted location.

This fact leads to the discussion of two points relevant to the present study, both of which are linked to agility in executing correction works in places impacted by geomorphological processes. The first point shows that this speed partially makes it impossible for specific case studies to be developed for these features, preventing the carrying out of measurements, material collection, analysis and structural tests of the same, seeking a better understanding. And also linked to the speed of the corrective works, we can highlight their ineffectiveness in the face of mitigation and / or containment of these processes, since there are no studies in a wide range that discuss the occurrence and development of anthropogenic induced processes in urban environments, the technical staff that makes up the public power ends up using inappropriate methods to remedy, correct or curb the appearance of the features in

question, by judging them inappropriately, disregarding their own and intrinsic characteristics, a fact that will contribute to the reappearance of these features in that same location within a time interval.

After these considerations, it is necessary to carry out a reflection on the aforementioned statements, since the relevance and the need to carry out specific scientific studies regarding the anthropogenic induced processes in urban areas is posed, it is necessary to understand the complexity of the case, because the impact of the appearance of a geomorphological feature in the middle of an urban center causes a break in the dynamics established there, causing disturbances of the most diverse possible extent. We can cite as the most common, the alteration in the normal flow of vehicles, since the feature can impact an arterial road with great movement, or displacement of residents, given by structural damage to the residences or even by the obstruction of access to them. Therefore, the concern to carry out works that remedy these facts as quickly as possible is something totally understandable, however, it is up to us at this time to seek means so that these impacts can be understood in the best possible way and that, in turn, the public power can act together with the themselves in the right way, developing effective measures to deal with induced anthropogenic processes and providing the impacted populations with the best service.

Figure 2 is the flowchart that aims to synthesize the genesis of occurrence of anthropogenic induced processes, showing the interaction between the factors that make up this dynamic. In this way, we have the presentation of the starting point of the process, represented by the “Rainy Event”, given that in tropical environments, such as the municipality of Uberlândia, the backdrop for this article, the predominant erosion processes have water as the starting point. The “Structures / Anthropical Actions” representing the range of actions performed and structures that make up the anthropized environments, emphasizing the urbanized areas, the focus of the present study.

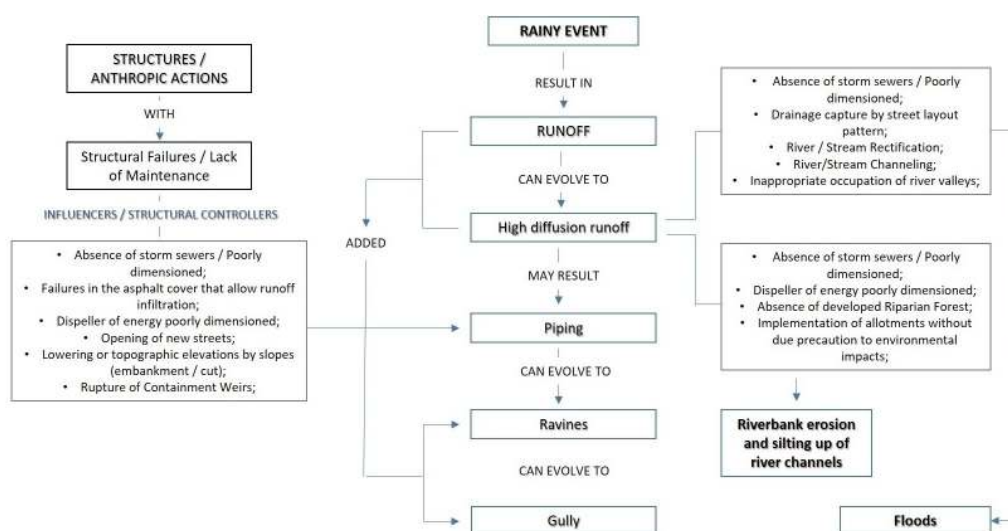


Figure 2 - Flowchart of the genesis of induced anthropogenic induced processes.

A list of “Influencing Factors / Structural Controlling” is also presented, which are linked to each class of erosion process, attributing to this the character of an anthropogenic induced process.

In this context, it is necessary to cross-reference this information in order to understand the concept that defines anthropogenic induced processes. To this end, the Rainy Event must be considered as an initial step, which may vary in terms of its intensity of occurrence, contributing directly in proportion to the impacts that may be generated. Since, with precipitation, the formation of surface runoff will occur, which given the intensity and duration of precipitation may lead to the formation of a high diffusion runoff. And when we use the expression “may”, it is due to the insertion of Influencing Factors / Structural Controlling in this equation.

Having precipitation as the first component of the equation, it is necessary at this moment to consider the existence and participation of the Structures / Anthropic Actions, through the existence of the Influencing Factors / Structural Controllers. Therefore, continuing the initial reasoning, forming the

surface runoff, we must take into account the structures that make up the surface of the relief where the processes have been developing.

In this way, it is necessary to pay attention to the fact that, in the case of an urbanized area, such a place may have total or partial waterproofing of the soil, as well as the existence or not of stormwater drainage galleries, of which the correct dimensioning of the themselves, or the existence of fissures or cracks that could compromise the full effectiveness of these structures. Since the aforementioned Influencers / Controllers Structural (soil waterproofing, existence and conditions of rainwater drainage structures) will directly contribute to the evolution and triggering of the referred anthropogenic induced processes. Given that surface runoff cannot be effectively drained during a more intense rainy event, it will start to gain volume, initiating an flooding process, or with greater volume and exposed to a scenario with greater slope, it will have greater speed. o consequently greater hydraulic potential.



Figure 3 – [A] Flood process recorded at the intersection of João Naves de Ávila and Anselmo Alves dos Santos avenues, Santa Mônica, Uberlândia-MG. [B] High difusion runoff occurred on Geraldo Abraão avenue, Santa Luzia, Uberlândia-MG.

In this condition, where the runoff, endowed with greater volume and speed, starts to present a turbulent flow characteristic, it starts to have a greater capacity for disaggregation and dragging of materials, directly favoring the occurrence of erosion processes. Processes that can again be conditioned by components linked to Structures / Anthropic Actions, since, as they occur in urbanized areas, the water flow tends to be directed to streets, starting to flow over the asphalt layer that makes up the road system of the place. In this way, the constructive and conservation conditions presented by this structure will interfere in the development of these processes, which, when faced with an asphalt covering weakened by cracks or discontinuities (holes), will start to infiltrate through these areas of fragility of the structure, which may cause several scenarios , depending on the intensity of runoff, the morphology of the terrain and the type of material to be eroded (soil or landfill, with specific texture, density and plasticity). In this context, in the impacted location, the emergence of ravines, piping and gully processes may occur, generated from high diffusion runoff processes, floods or both (Fig. 3). It is worth mentioning that the removal of material caused by these processes tends to be deposited in topographically low places, mainly characterized by river valleys, where river channels are primarily located. And again, having the urban environment as a backdrop for the statements developed here, we must stick to the facts that characterize urban river channels, of which we can mention the absence of a conserved riparian forest, due to the processes of deforestation triggered by urban expansion, in addition to the presence of energy dispeller commonly found inside permanent preservation areas (Fig. 4).

Therefore, part of the volume of material / sediment disaggregated and transported by runoff in its ordinary condition, or altered, represented by high transmission flows and floods, will reach the river valleys and will be deposited in adjacent areas and inside river channels. This path carried out by the flow when entering the permanent preservation areas through a diffuse flow, concentrated or directed by an energy dissipation system, may again produce erosion processes, whether these are new ravines and gullies, or even riverbank erosion (Fig. 5).

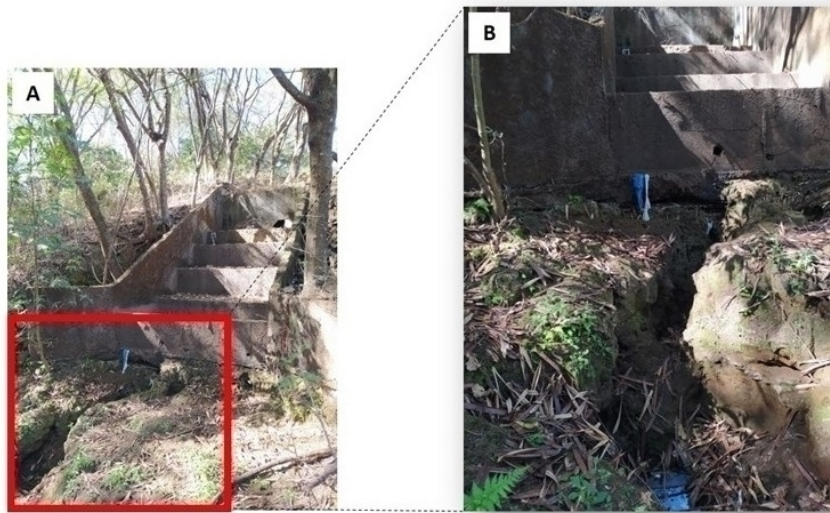


Figure 4 – Ravine inserted at the base of the energy dissipater, located inside the permanent preservation area of Buritizinho stream, Uberlândia – MG.



Figure 5 - [A] Riverbank erosion caused by runoff drained into the permanent preservation area of Buritizinho Stream, Uberlândia - MG. [B] Perpétua Stream silted bed, Uberlândia-MG. [C] Riverbank erosion in the Buritizinho Stream, in the image it is possible to identify that the erosion process is already beginning to compromise the stability of the existing vegetation in the place, exposing the roots of the trees

This succession of events that was presented, aimed to demonstrate how anthropogenic induced processes in urbanized environments can be triggered, so that each of the geomorphological processes presented had its occurrence linked to Structures / Anthropogenic Actions, while such interaction began to condition the form of occurrence, location and intensity of the processes in question. Whether from the existence of soil waterproofing, the insertion of structures that direct or stop the runoff, to changes in the structure of the soil surface, through grounding processes or removal of material.

APPLICATION OF THE CONCEPT OF ANTHROPOGENIC INDUCED PROCESSES IN URBANIZED AREAS

The mechanisms that are stimuli for the initiation of processes will be considered, which may vary according to the reality of the place to be studied. In this context, it should be emphasized that when dealing with geomorphological studies related to urban environments, it is necessary to understand the particularities that involve each of these, since the geomorphological dynamics of a given location can differ significantly when compared to another location. So that the urbanized areas located in mountainous regions with highlands, will have their geomorphological processes strongly conditioned to the dynamics of slopes, where the disorderly occupation of steep slopes, added to rainy events can cause significant damage such as the occurrence of falling blocks, mudflows or landslides. In municipalities with smooth relief, with a predominance of flat to slightly undulating areas, processes similar to those mentioned above will hardly occur.

However, other geomorphological and hydrogeomorphological processes are likely to occur, mentioning erosion processes such as ravines and gullies, margin undermining of the watercourses; in addition to flooding in the valley bottoms and flooding, often related to soil sealing and occupation of floodplain areas of rivers and streams in urban centers.

In this context, as an initial act, it is necessary to identify the range of existing processes in the area of interest, so that from the identification it is possible to evolve to the later stage, which is the analysis and understanding of their dynamics in view of the particularities of the place in question.

And among some of the processes commonly existing in tropical areas, the example of the county of Uberlândia-MG, it is possible to list, the ravines; gullies; margin erosion; and silting up of river channels, all these classified as geomorphological processes, in addition to high diffusion runoff and urban flooding, related to hydrogeomorphological processes. After carrying out the survey of the processes, it is up to the technical professional / researcher to interpret their dynamics, identifying influencing factors that may trigger, lead or aggravate any of the aforementioned processes.

Aiming to provoke the debate and the improvement of the discussions regarding the theme addressed in the article, some indications with conceptual pretension will be carried out, aiming to classify processes, as well as the referred factors that act as structural controllers of the processes in question.

Therefore, it is likely to indicate the existence of anthropogenic structural control in urbanized environments that can directly interfere in the form and dynamics of occurrence of geomorphological processes.

This control takes place primarily from existing buildings in urban centers that begin to condition the forces involved in the morphogenetic processes. Tucci e Bertoni (2003) they present the structural controllers in a generic way defining them as obstructions. It is possible to indicate as examples of structural controllers: the pattern of a neighborhood's road system; this can be radial, orthogonal, orthogonal mixed radial or linear (FERRARI, 1977), in such a way that each pattern will present its influence against the factors that make up the geomorphological processes, where we can highlight mainly at this point the conduction of surface runoff, involving your capture point and targeting (PEDROSA et. al, 2016); the existence of cut slopes or embankment, are also important controllers, since these are presented as topographic changes in the landscape, can be negative (cut slope) or positive (embankment slope), acting as a facilitator or obstacle respectively, when taken into account, for example, the surface runoff itself.

It is noteworthy that certain structures present in urban centers, such as rainwater drainage systems, will be influencing factors of the geomorphological and hydrogeomorphological processes acting there. While its poor dimensioning or even its non-existence as in some cases, will directly influence the behavior and consequences resulting from such processes. And such structures can also interact with subsurface processes, conditioning their behavior. As for this fact, it is possible to highlight the role of pipes, such as sanitation structures, which may be intended for water supply or sanitary sewage, varying in proportion and complexity according to the need and size of the municipality in question.

Therefore, the characterization of anthropogenic induced processes will occur from the following steps - 1. The identification of the geomorphological processes active in the place, which will be held from field visits, or by means of remote sensing products with adequate spatial resolution for viewing the features, emphasizing that the identification should be carried out as close as possible to the date of occurrence of the process, aiming to portray possible evolutionary steps of the same (Ex. regressive gully-head, piping collapsed, flood peaks / floods, between others); 2. Analysis of the dynamics of such processes, that must take into account, the starting place of the process and constituent materials, its position on the slope, direction adopted in its evolution and volume / size reached; 3. Indication of the existence of influencing factors and structural controllers in the studied location, which can be carried out from field visit, utilizing remote sensing tools, consulting official materials such as plans and maps that indicate the location of urban infrastructure; 4. Analyze the relations between the identified processes in front the influencers factors and structural controlling, so that after proving the direct relationship between them, they can be classified as anthropogenic induced processes (Fig. 6). Such a relations will take place from the application of technical / theoretical knowledge regarding the geomorphological processes in question, together with the study of the components that form the landscape of occurrence, in order to understand how the processes are developing in that place, to the step of noticing in this behavior points that differentiate them from their spontaneous / natural dynamics.

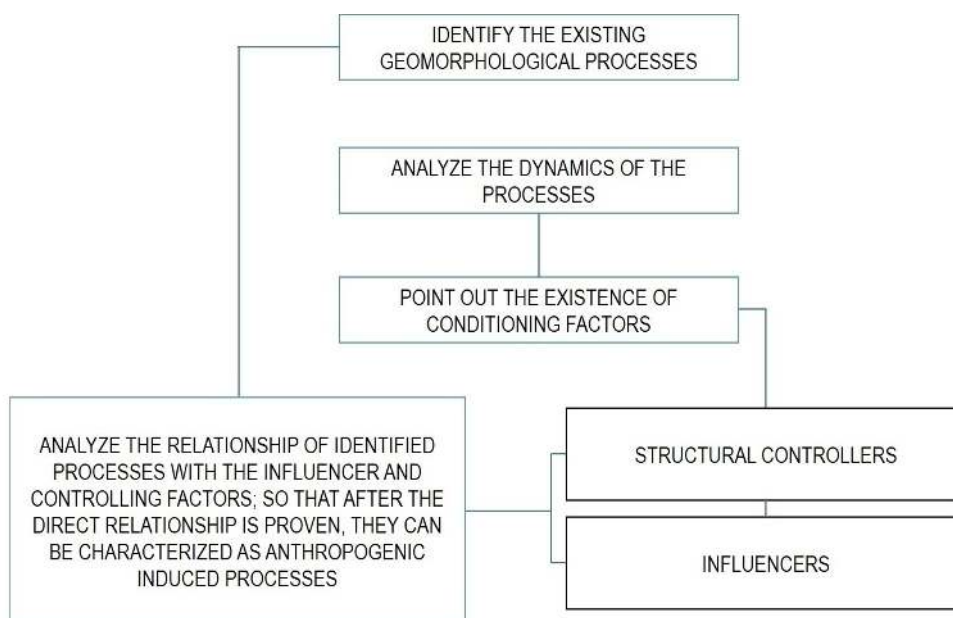


Figure 6 - Flowchart showing the necessary steps to identify anthropogenic induced processes.

Once the existing processes have been classified in the study site, the technician / researcher may have theoretical and applied tools to mitigate or contain possible damage caused by the effects of the anthropogenic processes in question, so that without such differentiation it would not be possible to carry out such measures, given that the behavior and impact generated by such processes do not follow the same logic and dynamics of natural/spontaneous geomorphological processes. Concluding that, the lack of understanding of this conceptual distinction makes decision-making difficult in dealing with impacts caused by anthropogenic induced processes, causing inconvenience to all sectors of society involved, whether these public authorities in their various administrative spheres or the civil population, which is predominantly the most affected by these occurrences.

CONCLUSION

The urbanization processes that occurred on the planet showed how human actions modify the Earth's landscape. Such changes range from small constructions carried out in antiquity such as a bridge

used to transport a watercourse, to huge structures that symbolize the current heyday of engineering works. In this context of significant alteration of the landforms by human actions, it was deemed necessary a conceptual input from the contents worked on by Anthropogenic Geomorphology, aiming to contribute to the interpretation of the geomorphological processes active in these altered landscapes, characterized by cities. Thus, the insertion of the concept of anthropogenic induced processes, together with influencer factors and structural controllers, aims to add efforts in dealing with the many occurrences of a geomorphological nature, which occurred in urban centers. Once the understanding of the processes that generate impacts to the infrastructures and the communities that live in these urban centers is placed as fundamental points for that right decisions are taken, aiming to mitigate or even solve the mentioned effects. However, it is expected that the points presented in this article will foment the debate about the relevance of anthropic actions in the face of relief modifying processes, with emphasis on urbanized areas, which are highly exposed to such alterations.

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