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# Physical and Spatial Characteristics of Slum Territories Vulnerable to Natural Disasters

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## **Abstract**

*The purpose of this paper is to explain how, in developing countries, the poor have creatively appropriated risky areas where urban settlement is prohibited, resulting in territories rich in organic and unique forms, adapted to the morphological territorial conditions (slope, height, profile) and to different risk situations. In this context, it is important to present the physical and spatial characteristics of slum territories taking into consideration the ways in which they are appropriated, presented, either in a “visible” or “hidden” manner in the urban landscape as well as locating them in a territory (outskirts or urban perimeter). Subsequently, the current urban forms shall be analysed, using irregular grid configurations, in corridors, terraces, etc., as developed by slum residents in response to the demands and topography of steep terrain. In order to achieve this, several slum cases shall be referred to in: East London (South Africa), Salvador de Bahia (Brazil) and Lima (Peru). Finally, the key points analysed within this article shall be presented briefly.*

## **1. Physical Environment of Slums**

To begin with, it is important to note that in the extensive literature on slums, often the focus is on how these settlements are created (Rapoport, 1988), “the process” rather than the characteristics that result from their constructed environments, “the product” (Rapoport, 1988). More specifically, the issue that has attracted the least attention from researchers is that of the management practices developed by the residents and their positive impact in relation to risk and natural disasters.

Rapoport has also praised the environmental qualities of slums: “Spontaneous settlements, like all human environments, do not just happen; they are designed in the sense that purposeful changes are made to the physical environment through a series of choices among the available alternatives” (Rapoport, 1988, p.52). Rapoport notes that the frequent success of this type of settlements in terms of formal qualities (aesthetic) and space, much more successful than the current, simplistic environments of professional designers, has resulted in an extremely rich environment with a range of unexpected reports. Other than the specific urban and architectural quality of slums (configurations of their plans and morphology), the author also looks at the use of materials, textures and specific colours, the territory’s effective response to the climate as well as the efficient use of resources and space. This quality of self-taught builders among slum dwellers, the ability to manage their buildings according to the environment in time and in space, “taking full advantage of the vagaries of climate, the topographical obstacles” are also noted by Rudofsky (1964, p.3).

It should not be forgotten that Rapoport, who opened one of the first debates on the “design quality” of “spontaneous” settlements, highlighted the “aesthetic or perceptual and formal environmental quality components of spontaneous settlements” (1988, p.51). He prefers to use the term “spontaneous” as opposed to “squatter” in that the latter evokes an essentially legal term (“land tenure”). However, Rapoport acknowledges the difficulty in using the term “spontaneous” for this type of settlement since it implies a self-generation and lack of conception which, in the case of slums, is naturally impossible.

## **2. Taking Possession of Slum Territory**

The possessing of slum territory takes place in a spontaneous or planned manner, individually or collectively, peacefully or violently. In this regard, it is important to mention that whether an invasion is planned or not can have a profound influence on future spatial organisation (Taschner, 2001, pp. 108 – 109).

In the “spontaneous” invasion, it should be noted that the first inhabitants of the land acquire a kind of ‘power’ over it and it is them that newcomers have to ask permission to occupy a piece of land to build their house (Taschner, 2001). In Latin American cases, as time passes and the slum dwellers get more organised, they will form a residents' association (with legitimately elected local leaders) whose main functions include monitoring the “land status” and “plot management” in the slum. As a rule, it is the Association management which, on assuming the role of Local Government, is responsible for the distribution of plots (Matos, 1977). They have the power to authorise (or not authorise) the installation of a newcomer to the slum and to determine whether an older slum resident, who owns a large plot, should share it with a new slum resident (Taschner, 2001).

In the case of organised or planned occupation, it is a form of invasion carefully prepared in advance, planned almost with a proposed subdivision of streets showing a similar urban landscape in shape, of a formal subdivision albeit of a smaller size (Taschner, 2001). Unlike the spontaneous occupation, the planned invasion has people creating an association, from the outset, to defend and maintain possession of the occupied land. This association is represented by leaders who, generally, are people who have taken over the responsibility of organising and directing the planned occupation of the area. The association becomes the governing local government body which has the responsibility of not only solving the problems of land ownership but also meeting the immediate needs.

In general, the physical and spatial configuration of the invasions, which was originally an organised and collective movement, is more regular, omitting the topographical characteristics of the territory, therefore increases the risk when these occupations are on slopes. On the other hand, it can be argued that the spontaneous occupations, scattered from the beginning, with time create organic urban forms which respect the morphological terrain conditions (slope, height, profile) better therefore, they are less vulnerable to the occurrence of natural disasters in the steep slopes.

### **3. The Establishment of Slums in (“Visible” or “Hidden”) Territories Vulnerable to Natural Disasters**

With regard to the “visible” establishment of slums on hills, it is necessary to mention that it can be a strategy, on the part of slum residents, against the authorities to ensure the future rehabilitation of the slum. Basically, when the slum is more “visible”, the greater the chance that it shall be suppressed by the authorities. Nevertheless, it is thanks to this “visibility” in the urban landscape that the authorities are often forced to take short to medium-term action to rehabilitate it in order to improve the image of the city, especially when the latter has tourism potential<sup>1</sup>.

It is important to note that these means of “striking and enlightening” (Rapoport, 1988, p.67) through which slum residents face the extremely steep slopes were often highlighted by authors such as Rapoport, who stated:

The solutions to difficult sites one can find among spontaneous settlements by far surpass the simplistic approaches of professional designers. They also more than equal the greatly admired traditional vernacular equivalents such as Greek Islands, Italian hill towns, and the “villages perches” of Southeast France (p. 67).

Regarding the location of slums “hidden” at the bottom of valleys, it is due to this “strategic” location that residents develop amazing communication networks between the slum and other districts located around it and they essentially succeed in escaping the control of the authorities (Centre des Nations Unies pour les Etablissements Humains, CNUEH, 1981). These “hidden” slums that develop very subtly, beyond the noisy dynamics of the city, have a communication network that allows them, through daily encounters, to connect simultaneously to four or five (or even more) districts of which they are secretly at the centre. Therefore, depending on how the slum dwellers occupy the hills or the plains, they will develop “mechanisms” or strategies for communication, of territory control and probably of risk minimisation to ensure they remain permanently in place.

### **4. Location of Slums in the Urban Perimeter or Outskirts**

Among the initial challenges that people face, after identifying the place they choose to occupy (hill or valley), is the adaptation of homes to the topography of the territory or to the general urban grid of the city.

First, it is imperative to distinguish between the slums that are located within the urban perimeter. Most of them correspond to districts that were initially on the outskirts of

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<sup>1</sup> In Salvador de Bahia (Brazil), a representative number of (“visible”) *favelas* have been the focus of home improvement programs (on a short-term, all the walls of the shacks in slums located in the proximity of the city centre were painted) to give a better image to tourists.

the city but were subsequently absorbed by the latter during the expansion of the city's urban area. Because of their new strategic location within the city, these areas occupied by slums have acquired a monetary value considered critical by the government and they often are a "Chinese puzzle" to government authorities. These neighbourhoods often have a very high population density because of the proximity to centres of economic activity and urban infrastructure (schools, hospitals, day-care centres, etc.) as well as access to sources of employment, which are often located in the city centre. For this reason, sizes of plots and open spaces are generally very limited. Faced with the impossibility of horizontal extension, development is mainly vertically by the continual addition of extra floors (CNUEH, 1981).

Secondly, it is important to mention the slums on the outskirts, located outside the urban perimeter and far from other areas of the city. For the residents, this distance from the centre limits access to infrastructure and urban facilities (very long journeys on foot or payment of transportation) which slows down the settling into the slums. As a result, the available land surface is greater compared to the slums located near the centre. This area is often used by residents to develop agricultural activities. This relatively low occupancy of the land thus promotes a better definition of the plots and parcels and is an important factor in the general configuration of the slum. Regarding this isolation of slum dwellers from the centre, authors such as Restrepo-Tarquino *et al.* (1998) find that it is precisely this distance that reaffirms the cohesion and solidarity networks between the slum residents.

## **5. Evolution of Slum Housing and Its Influence on the Urban Configuration**

In the slums, alternatives, constraints and choices are made informally and are not based on explicitly stated models or theories (Rapoport, 1988). In fact, when we talk about the architecture of slums, we refer to "an un-codified<sup>2</sup> architecture, anonymous, spontaneous" (Berenstein-Jacques, 2001, p.9).

In special cases with the slums of Latin America, the establishment of housing, in addition to being unplanned is also gradual (in steps). The house ownership is not only the result of total or partial construction of the unit, but also the result of a purchase (Taschner, 2001). In this regard, there is a direct relationship between the period of existence of a slum and the commercialisation of a house.

The cheapest houses are negotiated directly with the owner and the most expensive with intermediaries or real estate agents (Taschner, 2001). In the consolidated slums, it is the Residents Association which acts as notary. It is through the Association that most real estate transactions are carried out with regard to purchases, sales, donations, etc. Usually, this service is paid at between 1 and 3% of the value of the transaction (Taschner, 2001).

Looking at the progressive evolution of construction methods of Latin American slum housing in general, there is a gradual physical improvement over time, however with some

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<sup>2</sup> This term has also used by Bernard Rudofsky in his book *Architecture sans architectes: Brève introduction à l'architecture spontanée* (1964, p.1).

exceptions. Two extreme cases can be given. The first case is the slums on the outskirts of Sao Paulo (Brazil) which, from the 1990s, saw the beginning of the invasion directly done with “hard” building (Taschner, 2001). This trend accentuated by construction using “hard” materials is explained not only by the desire to have a “more solid and modern” house but also the assurance that this type of house represents the “right of possession” on the occupied plot; the greater the percentage of “hard” houses, the less the risk of expulsion. Moreover, having a permanent house provides an opportunity to seek services or compensation in the event of destruction or eviction.

The second case is illustrated by the South African slums of East London where housing, despite the passage of time, shows no sign of major physical changes (they do not “harden”). Although in both cases (Brazil and South Africa), the first temporary, precarious buildings such as *baraaques*<sup>3</sup> or shacks<sup>4</sup> are built with the same basic materials (wood, metal sheets, cardboard, plastic, etc.). In South Africa, this type of shack does not change significantly over time. The shack, which represents one of the most dominant and deeply rooted characteristics of the slum, was reproduced as an isolated unit in all the slums of South Africa with a private entrance and a single floor (made of very lightweight materials and easily portable). Despite the passage of time, people still retained the shack characteristics i.e. flimsy materials, self-contained accommodation and single storey (Buffalo City Municipality, 2002; Abbott *et al.*, 2001).

In Brazil, as well as in other Latin American countries, it was after five years that the slums were literally occupied. When the occupants feel that the invasion is successful (that they will not be expelled), they immediately build stronger homes (Lloyd, 1979 in McAuslan, 1986). Overall, ten years later, despite the irregular terrain, most (if not all) houses have been transformed into “hard” lodgings (brick, concrete, concrete blocks, etc.) and into two or three storeys (Lloyd, 1979 in McAuslan 1986; Turner, 1967). In the past decade, these institutions have the most basic services (water, electricity, roads, etc.). One of the strategies put in place, in order to obtain favourable responses to their demands from the authorities, is to give the slum the name of a politician (or his wife) who has not suppressed the invasion (Gilbert, 1990). In return, more often than not, the politicians respond positively to this strategy in order to increase their electoral vote in future elections.

All this information gives room for the inquiry of the validity of the “universal” principle of gradual development of spontaneous informal settlements proclaimed by Turner (1967, 1968, and 1976). In fact, although this principle is valid in the context of Latin American countries where the surroundings are changing gradually as the social situation improves, with the South African slums, the “shack” (hut) was, is and seems that it shall always be the same (that it will never be hard) over generations (Flores, 2006).

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<sup>3</sup> *Baraaques* is a Portuguese name that refers to the first home of slum residents in Brazil.

<sup>4</sup> *Shack* is the name that refers to the first home of slum residents in South Africa.

## 6. Current Urban Forms of Slum Territory

Of note with urban slum configurations, located on steep slopes vulnerable to natural disasters, the most common forms are those with an orthogonal type of framework (regular or irregular), adapted to a radial type of topography with a central corridor in the shape of platforms (terraces) and on flat heads of hills (Matos, 1977; Fundação de Desenvolvimento Municipal, FIDEM, 2003).

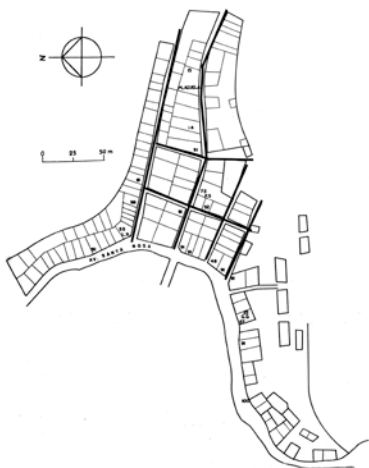
Although at first glance these urban settings, presented below, can greatly resemble a certain typology, it must be remembered that the appropriation of territory in slums is spontaneous and not codified. It is based on the location of the neighbourhood to the city (formal), topographic, soil and geotechnical features dictated by the area's terrain and climatic characteristics where the slum is located. Overall, while the configurations of some slums may have some similarities, it is impossible to find two slums with the same physical and spatial layout.

### *Grid Outline of Regular Slums*

This is an urban grid with parallel and transversal streets of nearly uniform dimensions, in the form of a grid or checkerboard pattern, located in areas of both steep slope and flat land. In fact, as there are regular patterns on rough terrain, it is possible to find a “disorderly” urban configuration on flat land (Matos, 1977, p.54).

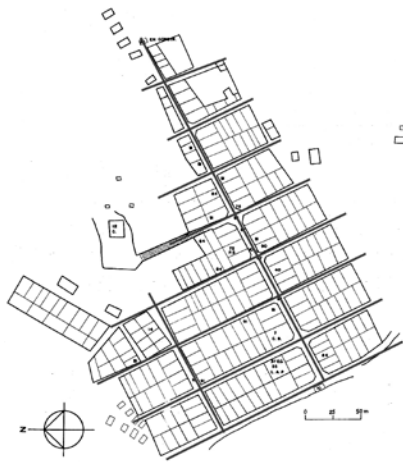
This orthogonal framed-occupation corresponds to a traditional form often adopted in a planned occupation where the sectors located on the hill do not take into consideration the topography of the land (FIDEM, 2003) (Figures 1 and 2).

**Figure 1:** *Santa Rosa Slum, Lima – Peru*



Source: Matos Mar, José. (1977). *Las barriadas de Lima 1957*.

**Figure 2 :** Tarma Chico Slum, Lima – Peru



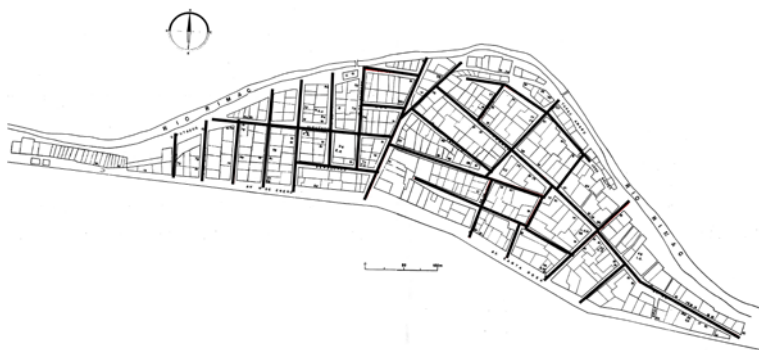
Source: Matos Mar, José. (1977). *Las barriadas de Lima 1957*.

This type of “traditional grid”, used successfully in the development of slums located on flat land in Latin America, usually offers a good base for subsequent improvements and installation of infrastructure (water, sewage, drainage networks, etc.) in the slums (CNUEH, 1981). The other advantage of this terrain occupation is the ease of subdivision. In contrast, when this frame is applied to steep terrain, road system installation and construction of buildings requires major interruptions as well as large soil movements. Furthermore, the longitudinal profile of the road system sloping upwards and downwards (in successive manner) restricts access to the slum and creates problems of consistency between the roads within the district. And, because of the discrepancy between the road system and the natural direction of water lines, this grid occupancy on the slopes disadvantages the establishment and the operation of infrastructure networks (FIDEM, 2003).

### ***Grid Outline of Irregular Slums***

The physical and spatial configuration of irregular shapes in form of a grid is found on both rugged and flat land (Figure 3).

**Figure 3:** *Dos de Mayo et Primero de Mayo* Slums, Lima – Peru



Source: Matos Mar, José. (1977). *Las barriadas de Lima 1957*.



### ***Slums Adapted to the Terrain Topography***

Slums adapted to the topography refer to a conglomeration of houses where the streets are just corridors without prior planning. These streets and corridors, which develop in response to the need for passage of the residents, are determined by topographic features of the terrain, extending over the spaces left free (because of their “impropriety” in the occupation) as the hills are already occupied. These narrow and tortuous pathways form complex networks which arise between the walls of houses, more precisely, their doors (Matos, 1977). This labyrinth of internal, winding and tangled streets inside the slums is seen by Berenstein (2001) as one of the special characteristics of the physical territory of Brazilian slums. Similarly, most of the South African slums also have the same type of physical and spatial configuration in their territory (Abbott *et al.*, 2001) (Figures 4 and 5).

**Figure 4:** *Cerro El Agustino and Santa Clara de Bella Luz Slums in Lima – Peru*



Source: Matos Mar, José. (1977). *Las barriadas de Lima 1957*.

**Figure 5:** *Duncan Village Slum in East London – South Africa*



Source: SETPLAN. (1999). *Duncan Village and Buffalo Flats, East London Transitional Local Council*.

Regarding this non- “orthogonal house” establishment, Bueno (1995) noted that this type of establishment reveals a richness, “a wisdom in the land ownership”. The apparent slum “disorder”, when compared to rigid urban planning according to Berenstein-Jacques (2001) promotes the creation of cities representing various human societies. This organic configuration, according to Matos (1977), highlights the skill and creativity of slum dwellers in the appropriation of land.

Despite the positive comments on the non-orthogonal frame, CNUEH (1981) points out that in certain circumstances, the irregular shape and limited available space prevents the development of traditional methods of waste collection and maintenance of networks (rain water, sewage, etc.) their simplicity notwithstanding. However, Bueno (2000) notes that the danger and wretchedness of slums are the result of people’s lack of resources and the lack of services and infrastructure rather than the consequence of the logic of their original location.

### ***Slums with a Central Corridor***

Slums with a central corridor are neighbourhoods that, despite the multitude of passages in their territory, have traffic that converge towards a central corridor, which gives the impression of a main axial focus, at times straight and other times winding, with a series of lateral branches (Figure 6).

**Figure 6:** *Mamede Slum, Salvador de Bahia – Brazil*



Source: CONDER. (2002). *CD Produtos Informes – Salvador - Photos aériennes de Salvador (1976, 1980, 1989, 1992 et 2002).*

### ***Radial-shaped Slums***

Radial-shaped slums are establishments, despite the fact that the streets were drawn at random, have acquired a physical configuration with a radial aspect. The establishment of this urban frame on the ground does not require large soil movements (compared to the

orthogonal grid). Since access is perpendicular to the contour, the establishments can be accessed by the main and secondary roads in the area (Figures 7 and 8).

**Figure 7:** Vila Natal Slum, Salvador de Bahia – Brazil



Source: CONDER. (2002). *CD Produtos Informes – Salvador - Photos aériennes de Salvador (1976, 1980, 1989, 1992 et 2002)*.

**Figure 8:** The Radial Arrangement of Traffic in Vila Natal in 2002



Source: CONDER. (2002). *CD Produtos Informes – Salvador - Photos aériennes de Salvador (1976, 1980, 1989, 1992 et 2002)*.

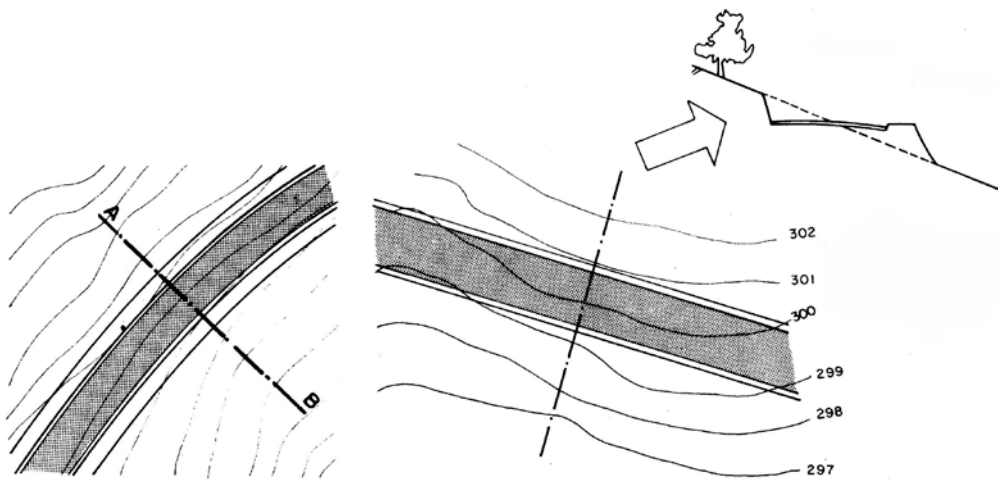
The main access to the hill is through long stairs that cut perpendicular to the terrain and from which arise a series of corridors that develop along the contour lines which are used for pedestrians as well as for accessing homes. Usually, these steps also serve as drainage elements (or the staircase itself with an open pipe on the sides) which assists in the flow of rainwater. Naturally, in the event of heavy rainfall, the main access often becomes impassable for residents.

Beyond the difficulty of access to the slum by cars (even fire-fighters and ambulances), this type of occupation also has some disadvantages for its occupants, particularly for the elderly and physically challenged who, on a daily basis, have to climb and descend the huge stairs against irregular and non-ergonomic rises.

### *Slums with Platform Occupation (Terraces)*

In this type of urban platform frame, the main access road is developed parallel to the contours of the land; the established houses following the curves of the land “as an expression, an extension of the naturalness of the site” (Figure 9).

**Figure 9:** Examples of Routes Parallel to Contour Lines



Source: Cunha, 1991, pp. 108, 110

This staircase establishment, according to Drummond (1981), can have a constructive explanation purely because of the steep slope of the terrain. In fact, for efficient use of materials, dictated by limited resources and the search for maximum stability of one's structure, slum dwellers prefer to cover the least possible space.

This creation of platforms or terraces on steep terrain is, when well done, a very effective risk reduction solution (Drummond, 1981). Indeed, some buildings such as stacked townhouses, built in stages, are considered as types of constructions that can consolidate the friable soil of slopes (Farah, 2002). This terrace configuration whose construction began at the lowest part of the hill and continued gradually up the slope, was often noted for its maximisation of land use, for its effectiveness in controlling soil erosion and for its more appropriate control of farming systems (Denevan, 2001; Zvietcovich in CONCYTEC, 1987). Thanks to the slight tilt of the platform, like the terraces of ancient times, there has been an effective control of erosion: water falls on the platform and runs fairly slowly, flowing without removing a significant amount of soil (in Cotler, 1987). Additionally, thanks to the geometric configuration of the urban system, a greater exposure to the sun has been fostered,

allowing the area to enjoy great light energy which has altered the soil and climate conditions thereby creating situations conducive to agriculture on a large hillside slope (Ramos, 1987 in CONCYTEC; Field, 1966).

### ***Slums Occupying the Hill Flat Heads***

This configuration applies only to urban slums that occupy the flat head of a hill without any treatment of the adjacent slope. Their establishment neglects the specifics of the topography by levelling the heads of the hill in order to obtain flat surfaces of large dimensions. This action, according to FIDEM, creates imbalances in the natural environment because it causes alterations in the mechanical properties of soil, disrupts the adjoining drainage basins and disturbs the vegetation cover. Furthermore, the hillsides (slopes), which were initially unoccupied, have been gradually invaded by other groups of people that follow the occupation trends thus aggravating the stability of the terrain (FIDEM, 2003).

### **Conclusion**

In summary, the physical and spatial configuration of invasions, from a collective and organised movement, is more regular. It takes little or no account of terrain topography which is probably more vulnerable to natural disasters than spontaneous occupations which create more organic and urban forms best adapted to the morphology of the land (slope, height, profile) than the former.

Depending on how the slums are presented in the urban landscape (“visible” and “hidden”) and how the slum dwellers occupy the hills or the plains that they will develop "mechanisms" or communication strategies, control of territory and probably risk minimisation to ensure their permanence in a certain place. In addition, depending on the location of the slum in the city, this location can have an immediate reflection on the physical and spatial configuration of the territory and to some extent on the different risk situations.

From the perspective of environmental protection and site preservation, each unique and creative form of land ownership has its advantages and disadvantages. While some of the physical-spatial configurations, such as slums adapted to the topography of the land, those arranged in radial form and the occupation terraces, promote minimisation of environmental risks i.e. non-occurrence disaster, there are other urban forms that can be considered as potential factors for increased risk of triggering natural disasters (steady plot a grid, flat heads of occupation of a hill, central corridor).

Although the information on physical-spatial configurations of the territory of the slums is important to get to understand the vulnerability of a disaster area, one should always put them in touch with the morphological characteristics, soil, geotechnical field, the characteristics of climate localized area where the slum, as well as factors related to the involvement of residents (management practices at the level of cuts and embankments, vegetation, basic infrastructure, etc.) due to their contribution to the vulnerability of the land .

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