A COMUNICAÇÃO DO PLANO DE EMERGÊNCIA MUNICIPAL DE DUQUE DE CAXIAS-RJ*

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RESUMO: O Plano de Emergência Municipal (PEM) como instrumento de apoio na incidência de riscos ambientais auxilia a comunicação junto à população diante de possível desastre, a partir do Gabinete de Gestão de Crise Municipal (GGCM). Este trabalho visa avaliar os procedimentos de comunicação de risco entre os agentes envolvidos e a comunidade do evento hidrológico que atingiu o município de Duque de Caxias-RJ entre 15 e 16 de janeiro de 2016. O GGCM integra ações de controle da comunicação entre a governança municipal e a comunidade com vistas à otimização de resposta às situações de eventos naturais extremos. Resultados apresentam equipes mobilizadas no atendimento de 58 ocorrências de áreas atingidas por alagamentos, inundações e escorregamentos. Conclui-se que o monitoramento hidrológico acompanhado de comunicação reversa participativa auxilia na prevenção de danos causados por desastres de eventos de inundação no atendimento à população em situações de risco ou de emergência.
PALAVRAS-CHAVE: Inundações urbanas. Desastre. Gestão do risco.

THE MUNICIPAL EMERGENCY COMMUNICATION PLAN OF DUQUE DE CAXIAS-RJ

ABSTRACT: The Municipal Emergency Plan (MEP) has proved to be a valuable support in tackling environmental risks by providing communication services to communities faced with possible disaster. The Municipal Crisis Management Office (MCMO) is responsible for disaster response and preventive action. The main purpose of this study is to evaluate the strategic plans for risk communication that were put into effect of the

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hydrological event that affected the town of Duque de Caxias in the January 2016. The MCMO carries out communication control procedures by the municipal authorities for the community. The results show that rescue teams were deployed in providing assistance in 58 cases of areas affected by landslides, flooding and soil erosion. It can be concluded that the hydrological monitoring and the assistance provided by communication at a local level, can help in the prevention of damage caused by disasters, and greatly assist communities faced with extreme hydrological events.
KEYWORDS: Urban flood. Disaster. Risk management.

INTRODUCTION

In general terms, the management of risks and natural disasters should be related to questions involving urban planning and investment in preventive and response measures, since this can assist in controlling the use and occupation of land in areas at risk.

At present, there is a recognition by local communities susceptible to hydrological disasters that risk communication is inadequate in so far as the information does not reach the affected population in an effective way and thus makes a rapid response to risks impossible (DI GIULIO, 2013). In contrast, participative risk communication (PRC) brings together key social players, such as residents, researchers, policymakers and government officials involved in risk management with the aim of extending the range of preventive measures and combating extreme hydrological events in vulnerable areas (RENN, 2008).

High-elevation regions that are densely urbanized, are more prone to natural disasters such as the collapse of hillsides and urban flooding. Historical records of extreme natural phenomena have only recently bem compiled and hence there is a need to combine systems for monitoring, modelling and mapping areas at risk, with contingency plans or preventive measures.

Most of the research studies on the impact of extreme hydrological events in Brazil and the rest of the world portray natural disasters by dividing them into the following categories:

(i) *historical* - with the aim of showing, determining and analyzing extreme events for the mapping of areas at risk (FARIAS JUNIOR *et al.*, 2013; DOURADO *et al.*, 2012);

(ii) *public health* – to assess the socio-environmental effects of natural disasters on the infrastructure, public services and the health of the population affected (FREITAS e XIMENES, 2012; HSU *et al.*, 2011; MURPHY *et al.*, 2010; DU *et al.*, 2010; DAI, 1992);

(iii) *adaptation and vulnerability* - finding a way to build up urban resilience and provide risk management in response to climate change and health warnings (FARIAS JUNIOR *et al.*, 2013; KIM e CHOI, 2011; HAINES *et al.*, 2006) and

(iv) *humanitarian support* – seeks to provide assistance in the coverage and logistical planning of those affected by natural disasters (HORITA *et al.*, 2015; POSER e DRANSCH, 2010; GOODCHILD and GLENNON, 2010).

One-off measures have been implemented as a means of addressing one of these factors, as in the case of the town of Duque de Caxias, RJ. After setting up the Municipal Emergency Plan (MEP) - or ¨Summer Plan¨ - the town formed a number of strategies to bring together the various sectors of policymaking and the civil society community with the aim of optimizing the response measure to the emergencies and disasters that occurred in the town. Following the strengthening of the National Civil Defense Policies implemented in 2012 (BRASIL, 2012), disaster risk management obtained the support of different government bodies which heightened the awareness of multidisciplinary environments of the need to prevent, or take steps to prepare for, natural disasters.

The peculiar environmental features of the lowlands, intensified by anthropic factors, are conducive to the outbreak of natural disasters, in particular those of a geological or hydrological kind. The heavy rainfall which is experienced in the upper parts of the basin, causes significant changes to the drainage system, especially when the water reaches the plains and this leads to much more frequent occurrences of mass movements of soil, erosion, flooding, torrents of water and landslides.

The MEP of Duque de Caxias-RJ follows risk communication procedures in so far as it adopts strategic management measures to reduce the risk of disasters in the town so as to avoid failures in communication by the parties involved, as well as to form closer ties between the administrators and the communities in the areas at risk.

The aim of this study is to characterize the effectiveness of disaster risk communication, especially in the period when there was torrential rain in the town of Duque de Caxias-RJ, (15th-16th January 2016). In this way, it will be possible to determine the consequences of the events, the guidelines for action and the procedures taken by the public authorities.

METHODS

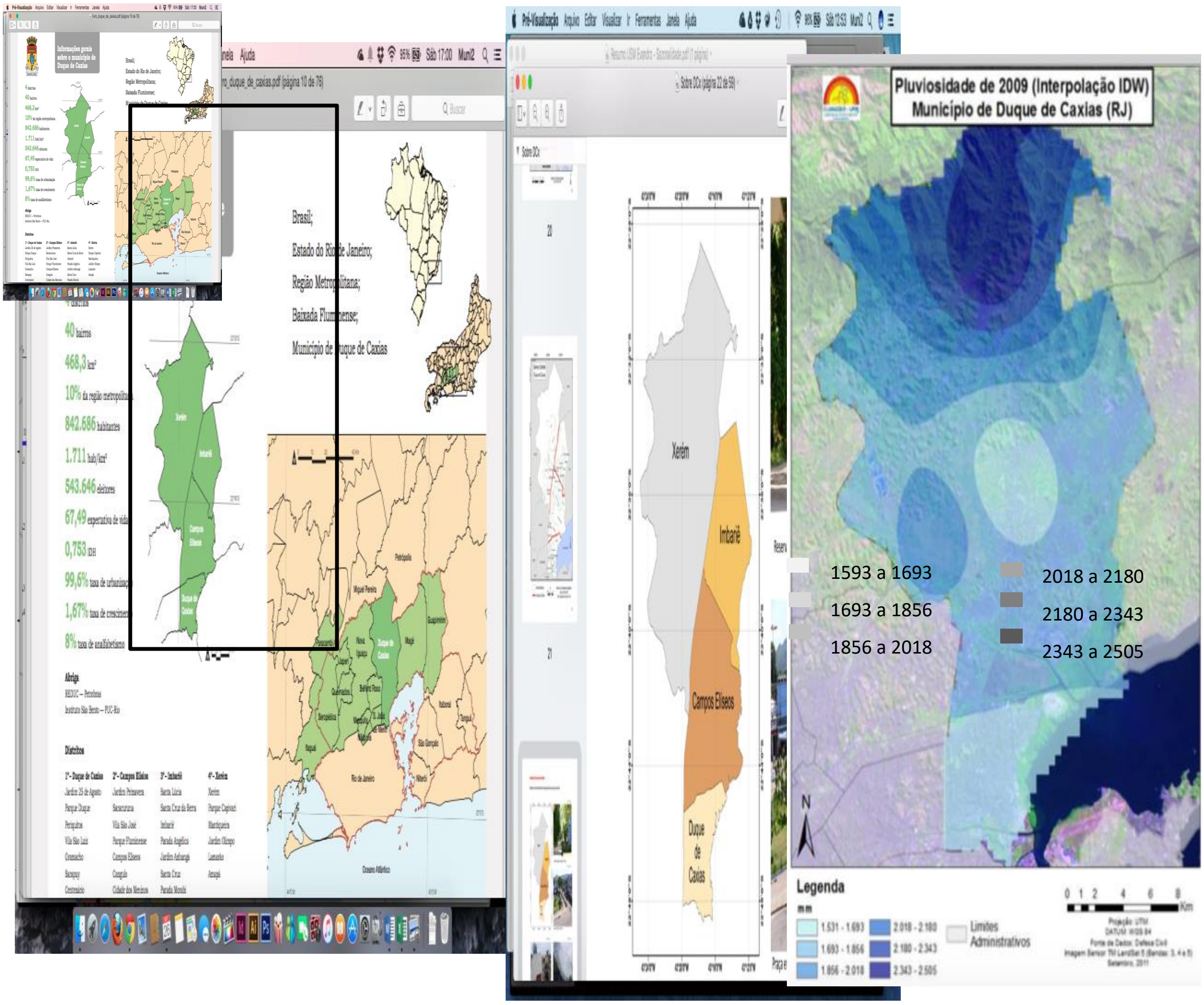
Area of study

With a surrounding area of 467.6 km^2, the town of Duque de Caxias-RJ has a population of about 882,729 inhabitants, with around 99% of them living in the urban area (IBGE, 2015). Although there is convective and frontal rain in the region, what is most predominant in the town of Duque de Caxias-RJ is orographic rainfall with an annual average of 1300 mm and temperature of 23.2 °C. The region has contrasting topographical features with a landscape accentuated by mountain ranges and lowland plains. This intensifies the hydrological processes in the basin, in particular the increased volumes of surface drainage in these areas. These effects are also caused by the backwater curves in the contours of water from certain canals in the town and also influenced by the tide since the region is located at the north-east end of the Guanabara Bay.

The town is divided into four districts which are listed in descending order of urban occupation: Duque de Caxias, Campos Elíseos, Imbariê and Xerém (Figure 1). All these places have, to some extent, faced problems caused by the slippage of land in the mountain slopes, urban inundation, flooding of public highways and mudslides.

There is a much larger amount of rainfall in the mountainous regions which leads to a greater concentration and spillage of water to the plains below where the district of Xerém is located (Figure 1).

Figure 1 - Location of the town, districts of Duque de Caxias-RJ



Source: Location of the town, districts of Duque de Caxias-RJ (PDC, 2008) and annual rainfall in mm (OSCAR and BRANDÃO, 2009).

Although structural measures have been taken in the region with a view to mitigating the effects of the disasters, especially by the Director of Planning for Hydric Resources in the Rio Iguaçu-Sarapuí Basin (SERLA, 1994), the town of Duque de Caxias-RJ still lacks effective measures that can assist in the risk management of natural disasters.

There were 35 recorded serious events caused by heavy rain in the period 2008-2015, which did not necessarily affect the population but caused some kinds of crisis in the town, such as problems of water supply, traffic complications and an accumulation of rubbish in the streets (BARCELLOS *et al.*, 2016).

Municipal Emergency Plan (MEP) and Hydrometeorological Monitoring

The MEP was first based on data obtained from the mapping of areas at risk of flooding and erosion, as defined in the Municipal Plan for Disaster Risk Reduction (REGEA, 2013). The monitoring system that is implemented depends on funding schemes that are supported by the federal government. It consists of a total of 18 sirens installed at strategic places in the town, with a coverage of approximately 50% of the R3/R4 high-risk areas (REGEA, 2013) and assists in the system of prevention, preparation and mitigation of natural disasters in the city.

The sirens and the response procedures operate within the communication risk management strategies of the community´s local flood warning systems or A2C2I, as a tool used in the town to reduce disasters and mitigate their effects. The schedule for the different stages of the operation involved public officials, and people from private enterprise and organized civil society, together with volunteers and community leaders, as well as the inhabitants of the vulnerable regions, in activities involving qualifying and training personnel, monitoring and issuing alerts and alarms.

Risk communication varies in accordance with the intensity of the rainfall observed at the monitoring stations and these define the stages of the operation and the teams that are deployed (Table 1). It should be made clear that changes in the schedule occur when values of intensity are reached (together with the weather forecast) that suggest there may be an accumulation of cloud in the next few hours.

Table 1 - Operational stages of communication

Pluviometric intensity (mm/h)	Operational stage	Team in action
12	(1) Surveillance	Stage 1 Team: on duty 24 hours
22	(2) Attention	Stage 1 Team + members of the management
34	(3) Alert	Stage 2 Team + sub-secretaries, operational teams and community protection + municipal administrators + community leadership.
40	(4) Alarm	Stage 3 Team + municipal secretary + permanent staff + population

Source: Adapted Duque de Caxias, 2016.

In summary, the team in action for the stage of surveillance includes a specialist in meteorology who provides information every hour and the team on daily duty which have a daily supervisor and three civil defense officials. The Attention Stage includes ten directors as well as the team that is already present. After this, the Alert Stage adds four municipals civil defense subsecretaries to the group, together with six municipal secretaries. In the Alarm Stage, the Secretary of Civil Defense joins the permanent staff and the community is given assistance at the support points stipulated for civil defense.

SAC-RJ makes use of three pluviometric and two fluviometric stations installed in the lower region of the River Capivari basin (Table 2), namely: (1) Ponte Ferro Capivari, in the River Capivari basin, (2) Santa Cruz da Serra, located in the River Saracuruna basin and (3) Xerém – Mantiquira, in the River Capivari basin.

Table 2 - Location of the monitoring stations of INEA, in Duque de Caxias-RJ

Station	Basin	Measurement	Latitude	Longitude
Ponte Ferro Capivari	River Capivari	Level and rainfall	22°40'S	43°20'W
Santa Cruz da Serra	Rio Saracuruna	Level and rainfall	22°38'S	43°17'W
Xerém – Mantiquira	River Capivari	rainfall	22°33'S	43°18'W

Source: Adapted INEA, 2021.

The hydrological station locarted at the Ponte de Ferro Capivari [Capivari Iron Bridge] belongs to the 4th District of Xerém and the Santa Cruz da Serra station in the 3rd District of Imbariê. As well as these, the National Center for Monitoring and Early Warning of Natural Disasters – CEMADEN - supplies data through the network in the town which relies on 14 automatic pluviometers (Table 3).

Table 3 - Location of the CEMADEN pluviometric monitoring stations in Duque de Caxias-RJ

Station	Basin	Latitude	Longitude
Xerém	River Capivari	22°34'S	43°18'W
Xerém 2	River Capivari	22°35'S	43°17'W
Xerém 3	River Capivari	22°34'S	43°18'W

Jardim Mariana	River Capivari	22°41'S	43°21'W
Santa Cruz da Serra	River Saracuruna	22°38'S	43°16'W
Jardim Anhangá	River Saracuruna	22°38'S	43°14'W
Taquara	River Taquara	22°37'S	43°14'W
São Judas Tadeu	River Iguaçu	22°39'S	43°17'W
Pilar	River Iguaçu	22°41'S	43°17'W
Cidade dos Meninos	River Iguaçu	22°42'S	43°17'W
São Bento	River Iguaçu	22°43'S	43°18'W
Sarapuí	River Sarapuí	22°45'S	43°18'W
Jardim Olavo Bilac	River Sarapuí	22°47'S	43°19'W
Parque Duque	River São João de Meriti	22°48'S	43°17'W

Source: Adapted INEA, 2021.

In addition, some of the sirens installed by CEMADEN-RJ have pluviometers attached to them, which allow the monitoring to be carried out through the National CEMADEN platform (this division can be seen in Table 4). Altogether, there are 18 sirens and six of them are pluviometers. All the stations and sirens and the district they belong to, can be observed in Figure 2.

Table 4 - Location of the sirens for CEMADEN-RJ, in Duque de Caxias-RJ

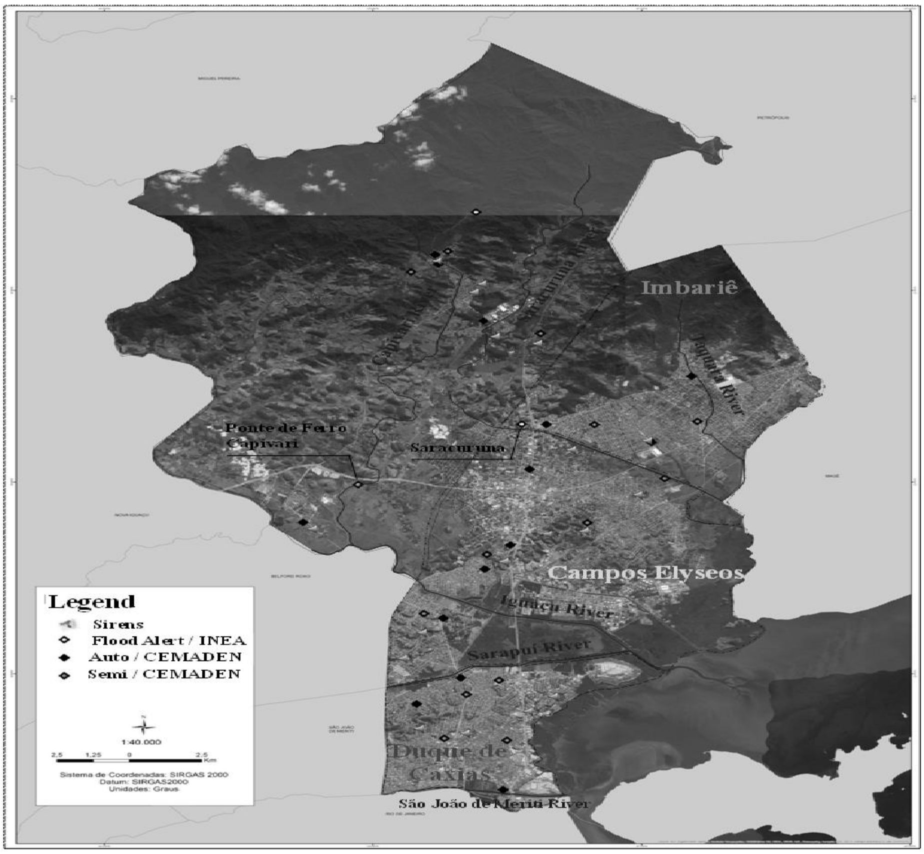
River Basin	Station	Measurement	Latitude	Longitude
Capivari	Xerém	Siren and Rain Rain	22°34'S	43°18'W
	Pocilga	Siren	22°34'S	43°17'W
	Estrada do Garrão	Siren	22°35'S	43°18'W
	Xerém 2	Siren	22°36'S	43°17'W
	Amapá	Siren	22°41'S	43°21'W
Saracuruna	Santo Antônio	Siren and Rain	22°36'S	43°16'W
	Jardim Anhanguá	Siren	22°38'S	43°14'W
	Parque Paulista	Siren	22°39'S	43°16'W
	Vila Urussaí	Siren and Rain	22°40'S	43°15'W
Iguaçu	Parque Uruguaiana	Siren and Rain	22°41'S	43°16'W
	Jardim Primavera	Siren	22°41'S	43°16'W
	Pilar	Siren	22°42'S	43°17'W
	Parque Fluminense	Siren	22°43'S	43°19'W
Sarapuí	Pantanal	Siren and Rain	22°44'S	43°19'W
	Jardim Gramacho	Siren	22°45'S	43°16'W
	Jardim Gramacho	Siren and Rain	22°45'S	43°17'W
Meriti	Centenário	Siren	22°46'S	43°19'W
	Corte Oito	Siren	22°46'S	43°18'W

Source: Adapted INEA, 2021.

The pluviometric data are obtained in real time from the monitoring system of the National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN) and the Early Warning System of Heavy Rain, in Rio de Janeiro (SAC-RJ), as a means of integrating the analysis with the Civil Defense team of qualified technicians of Duque de Caxias.

The hydrometeorological monitoring takes place 24 hour a Day, 7 days a week (24/7), initially in the stage of surveillance. As the intensity of the rainfal reaches the limits indicated, the operational stages are altered for the action of the team. Throughout the period of monitoring, data on the patterns of rainfall and levels of water in the river are drawn on, as well as the communication between the Civil Defense specialists.

Figure 2 - Location of monitoring posts



Source: Duque de Caxias, 2016.

Another source of communication is the Civil Defense Community Centers (NUDECS), which depend on the leadership of the local community who are immediately alerted about changes in the stage and then inform the residents of each change in the procedure. The volunteers and friends of the community who are registered in the network (SVAC), are sent e-mails and text messages giving information about the locality where there has been a change in the stage. This shared information makes it possible to determine the situations in the region that are likely to be at a critical level, particularly in areas without the coverage of monitoring posts in real time.

Triggering of the Sirens

When heavy rainfall is recorded by the monitoring system, the stages are altered so that at the moment when it reaches the water level alarm, it is necessary to trigger the sirens that are responsible for Civil Defense. At this time, action is taken by the participative risk communication during which the people who are informed and trained, show the effects of the decision-making by being directed to a safe place such as a support point or home base that has been established in advance by the Civil Defense or another spot that is away from the areas at risk. The Support Points act to assist and give support to the people by giving basic information about the event and supplying water and food, as well as assisting in the necessary procedures for coping with an imminent disaster situation, in particular through risk communication.

The subsecretary for community protection is responsible for the first measures by making contact with the community leaders and trained volunteers, in combination with the teams of public officials who travel to the place where assistance is needed.

Operational measures and the Head Office (MCMO)

The operational measures are carried out in the phase that involves a response to what is believed to be an extreme event or an imminent disaster. In this stage, communication is directed at occurrences caused by an event that has been detected by the hydrometeorological monitoring, in a way that involves humanitarian reverse logistics and information assurance, as a response by the people to the public body responsible.

The subsecretary of the operations supervises the response measures and the technical inspection, as requested by the community leaders, volunteers and calls to the emergency 199 phone number of the Civil Defense. The calls become a tool for detecting anomalies or abnormal situations. The Civil Defense Communications Center receives, on average, 40 phone calls per day in normal periods, while in periods of abnormality, this number is exceeded, according to the information given by the Civil Defense Communications Center of the town. After receiving a request, the operational team begins the process of inspection, depending on the degree of risk and the requirements.

The MCMO is an innovative system of the MEP of Duque de Caxias-RJ and serves as a municipal physical environment established in the presence of the different teams of public officials and active volunteers that follow the forecasts and the occurrence of hydrometeorological events. The Head Office, which was set up to be responsible for organizing and improving response measures to emergencies and disasters, also coordinates the municipal secretaries to ensure that the communication is shared with all those involved in an effective way. The procedures allow a broadening of the support measures and assistance to the public in situations of abnormality.

The federal entity must send the Disaster Information Form of the Ministry of Integration as a means of recognizing situations of emergency or public disaster. In this way, it becomes an instrument for releasing resources that can provide information of the extent of the damage resulting from disasters.

RESULTS

Hydrometeorological Monitoring

Data obtained from the monitoring system indicate that there was a heavy deluge of rain in the town of Duque de Caxias-RJ on 15th January, 2016, This region is characterized by the South Atlantic Convergence Zone (SACZ) and extensive nebulosity spreading south of the Amazon region to the South-East of Brazil and covering the Center-West region and the coastal strip by the Atlantic Ocean. Through the Brazilian Coding System for Disasters (COBRADE), the phenomenon can be classified as heavy rain (encoded as 1.3.2.1.4), owing to the excessive volumes accumulated in particular locations and multiple disasters such as floods, mass movements of soil and mudslides.

The observed data recorded variations in accumulated rainfall over a period of 24 hours between the 5 pluviometric monitoring posts of CEMADEN and SAC-RJ. Among the regions monitored, the post located at Morro da Caixa d'Água obtained the greatest amount of rainfall in the 24-hour period, with around 212 mm. In contrast, in the same period the pluviometric post at Parque Duque recorded 101 mm (Table 5). The average volume of rainfall was calculated as 149 mm and with a standard deviation of 48 mm gave clear information about the pattern of rainfall, despite the proximity of the posts in the region.

Owing to the very high rate of accumulated rainfall in the region at 23 hours on 15th January 2016, CEMADEN-RJ determined that there was "A high risk of mass movements of soil" in the town of Duque de Caxias-RJ. The accumulation of 73 mm of rainfall in an interval of 1 hour observed in the post located in Morro da Caixa D'água, was enough to activate the alert/alarm stage in the region.

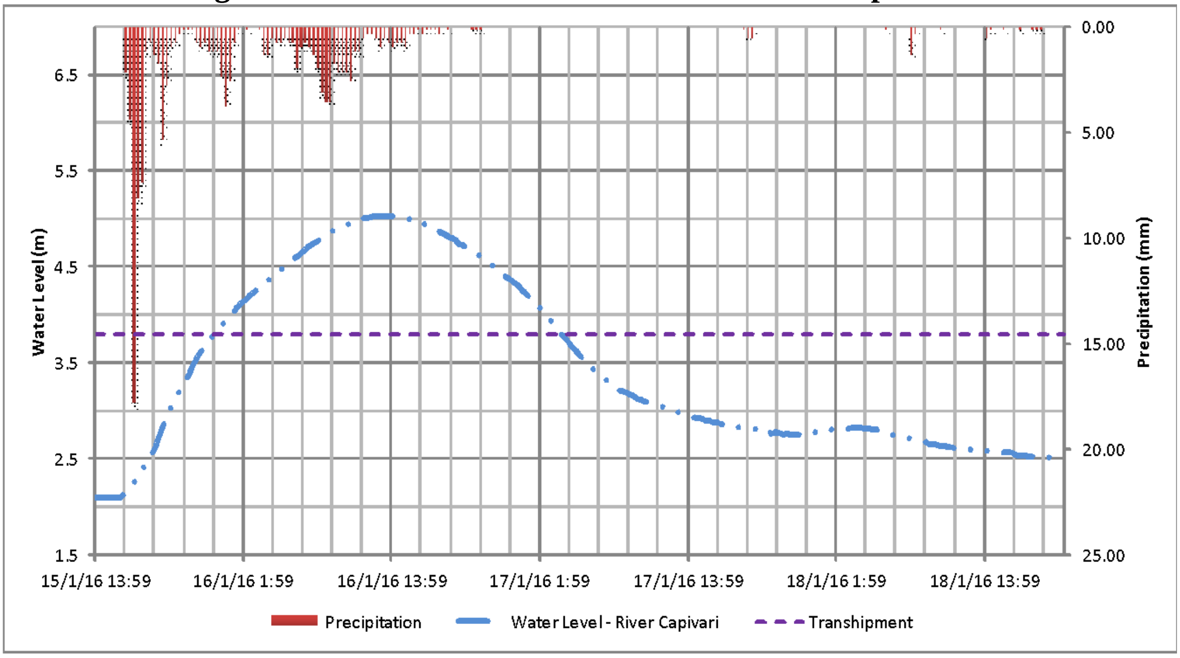
Table 5 - Accumulated rainfall in a period of 24 hours at the pluviometric posts

Pluviometric Post	Accumulated rainfall (mm)
Jardim Olavo Bilac	111.71
São Bento	135.06
Parque Duque	101.09
Morro da Caixa d'água	212.00
Santo Antônio	188.20
Arithmetic Average	149.61
Standard Deviation	48.43

Source: made by the author.

Data obtained from the SAC-RJ made it possible to record the extent of the overflow of the rivers Capivari and Saracuruna. At the Ponte de Ferro Capivari station (water level and rain), the River Capivari reached a peak of 5.03 metros, about 1.20 meter above the overflow limit of 3.80 metros for accumulated rainfall of 123 mm in 24 hours (Figure 3). At the Santa Cruz da Serra station (water level and rain), the River Saracuruna reached a peak of 3.94 metros, about 0.14 meters above the overflow of 3.80 m, which was considered to be disastrous because it indicated points of flooding in particular districts and recorded 157.20 mm in 24 hours (Figure 4). The material damage caused by these rainfall events (inundations, flooding and landslides) led to communications and calls for assistance from the town´s Civil Defense Operational Team.

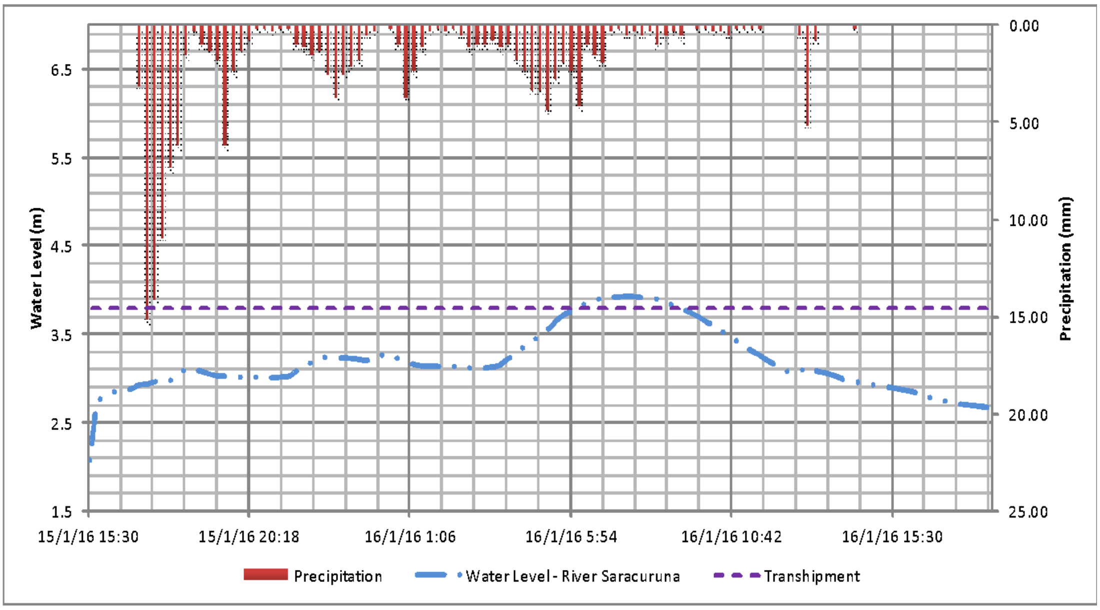
Figure 3 - Water level and rainfall in the River Capivari



Source: made by the author.

The overflow of these rivers had a serious effect on rivers downstream such as the Rivers Pilar and Calombê, and a rise in the level of River Iguaçu. Contact with the community leadership showed that flooding had been recorded in other places in the town such as in the Farias canal, Vila Urussaí and Caboclo canal.

Figure 4 - Water level and rainfall in the River Saracuruna



Source: made by the author.

Triggering of the sirens and operational measures

Six PAs were opened after the following: the change to the alarm stage, the rise in the level of the rivers, the increase in requests made through the 199-emergency number, the worsening of situations observed in the monitoring and the order to activate 3 sirens. After this, a total number of 84 Civil Defense officials, Municipal Guards and Social assistance personnel were involved in assisting the people located in the areas at risk.

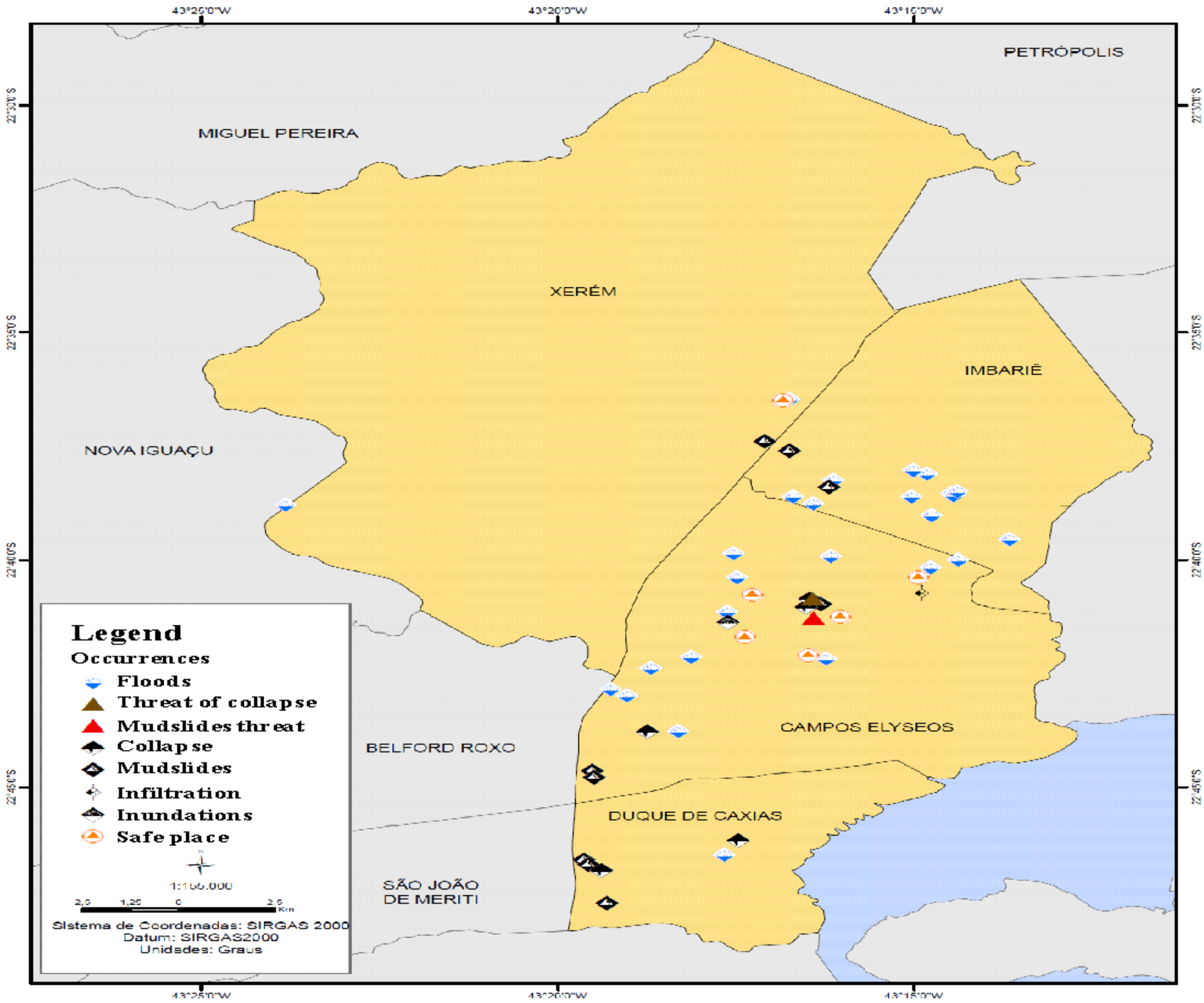
The control of the measures taken by the operational team was of an innovative kind with regard to communication and as it took place within the MEP, it was possible to chart the occurrences triggered by the event under study. As a result, this chart could be planned.

The map for locating the occurrences showed the places where flooding occurred, the areas under water, the threats of landslides from slopes and the support points available to the people (Figure 5).

The separation of occurrences into mudslides, falling rubble, flash flooding and inundations became a matter of internal communication between the service teams and the groups of technical researchers on disasters. This allowed an exchange of information that was shared with the different organizational sectors as a means of improving the disaster response system.

A total of 58 occurrences were recorded which included 24 floods, 15 mudslides, 11 cases of falling rubble, 5 inundations and 3 other related causes. These occurrences led to 20 embargos on property development where there was a serious risk of collapsing rubble and 12 subpoenas on the need to make alterations to the building. However, 40 people were displaced from their homes and assisted in the open PAs.

Figure 5 - Mapping of the occurrences of the observed event



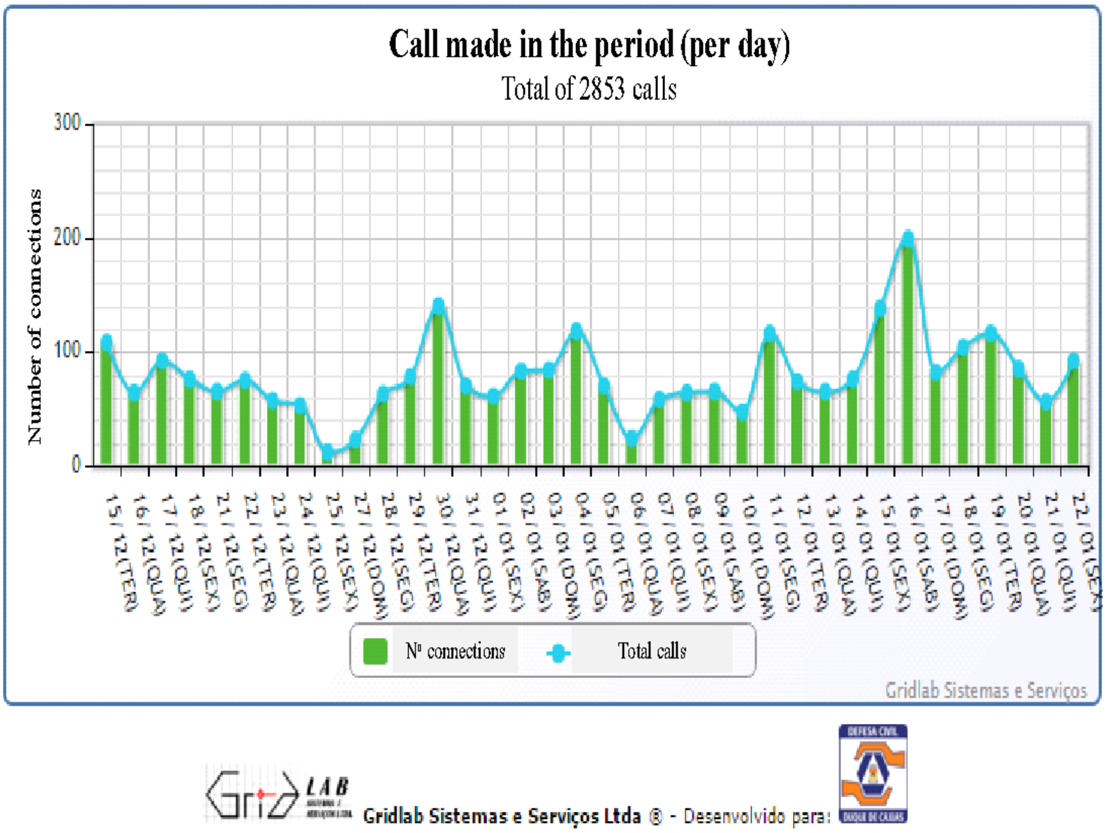
Source: Duque de Caxias, 2016.

The occurrences covered the four districts although that of Campos Elysios suffered most (mainly from flooding) and more than 25 boroughs were affected. With regard to the system of controlled links received by the town´s Civil Defense

Communications Center, during the event more than 300 phone calls were recorded between the 15th and 17th January 2016 (Figure 6).

As well as the Executive Secretary of civil Defense, the management put into effect by the GGCM, includes other municipal authorities such as the Mayor, Deputy Mayor, Municipal Secretaries of Works, Social Assistance and Human Rights, the Environment, Planning, Housing and Urbanism.

Figure 6 - History of recorded phone calls.



Source: Duque de Caxias, 2016.

Consolidated social communication applications such as whatsapp groups constitute the support features for the community in general. GGCM has become a permanent body since records were first kept of rainfall, and was on standby until the activities for prevention and response on 19th January 2016, were declared to be terminated i.e. until when the effects of the occurrences were under control and the town could return to the normal state of surveillance.

CONCLUSIONS

The following conclusions can be drawn from this article:

(1) The abnormal situation which began in the town of Duque de Caxias-RJ, in the afternoon of 15th January 2016, led to the operational installation of the Crisis Management Head Office and an improvement in communications management between the municipal authorities and the affected community;

(2) The hydrological monitoring and creation of a database for disasters in the town means that information can be supplied which can assist in the prevention of the damage caused by disasters, in particular flood events;

(3) Participative risk communication, which involves activating sirens and taking operational measures, such as the creation of the GGCM, helps in bringing the town secretaries together and makes it possible to give assistance to people in abnormal situations or suffering from extreme hydrological events.

As in the case of Duque de Caxias, several Brazilian towns and cities still need to adopt a wide range of structural and non-structural measures to reduce the risk of disasters. It is recommended that the town should gradually build up resilience as well as to make improvements in the MEP/Caxias so that it involves more secretaries in the town, as well as work related to civil defense operational activities based on scientific and technical knowledge.

Acknowledgments

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