Revista Tecnologia e Sociedade
ISSN: 1809-0044
ISSN: 1984-3526
rts-ct@utfpr.edu.br
Universidade Tecnológica Federal do Paraná
Brasil

Souza, Fabio Teodoro de; Ultramari, Clóvis; Hummell, Beatriz
A pragmatic acceptance of short term policies: the case of floodings in Curitiba, Brasil
Revista Tecnologia e Sociedade, vol. 14, no. 30, 2018, January-April, pp. 202-216
Universidade Tecnológica Federal do Paraná
Brasil

DOI: https://doi.org/10.3895/rts.v14n30.5632

Revista Tecnologia e Sociedade
ISSN: 1984-3526

https://periodicos.utfpr.edu.br/rts

A pragmatic acceptance of short term policies: the case of floodings in Curitiba, Brasil

Fabio Teodoro de Souza
fabio.teodoro@pucpr.br
Pontifícia Universidade Católica do Paraná – Curitiba, Paraná, Brasil.

Clóvis Ultramari
ultramari@yahoo.com
Pontifícia Universidade Católica do Paraná – Curitiba, Paraná, Brasil.

Beatriz Hummell
hummellb@yahoo.com.br
Pontifícia Universidade Católica do Paraná – Curitiba, Paraná, Brasil.

ABSTRACT

This is a discussion on social vulnerability and the construction of a warning system in a broader scenario of non-fulfilled demands and increasing risks, aiming at the elaboration of public policies concerning natural disasters in urban areas. Empirical exercise takes place in the city of Curitiba, Southern Brazil. Article is based on both conceptual approaches revealing complexity of such topic as well as on risk reduction action facing natural adverse events. Case study describes a statistical procedure to identify risks and allow preparedness action taking place 24 hours before events. Urban context is that of Brazilian cities, revealing persistent spatial inequalities in the way inhabitants build, use, and transform urban compartments. Research presented can be contextualized in a scenario where adverse phenomena should deeply influence the elaboration of long term urban public policies but, according to a necessary pragmatism, also indicate emergency tailored actions. Conclusions indicate that 1. Urban management institutional framework can count on models to predict flooding impacts and reduce human and economic losses, and 2. Expertise in emergency action cannot lure the need for structural changes and long-term planning actions.

KEYWORDS: Natural Hazards. Data Mining. Floods. Classification Rules. City of Curitiba.

FOREWORD

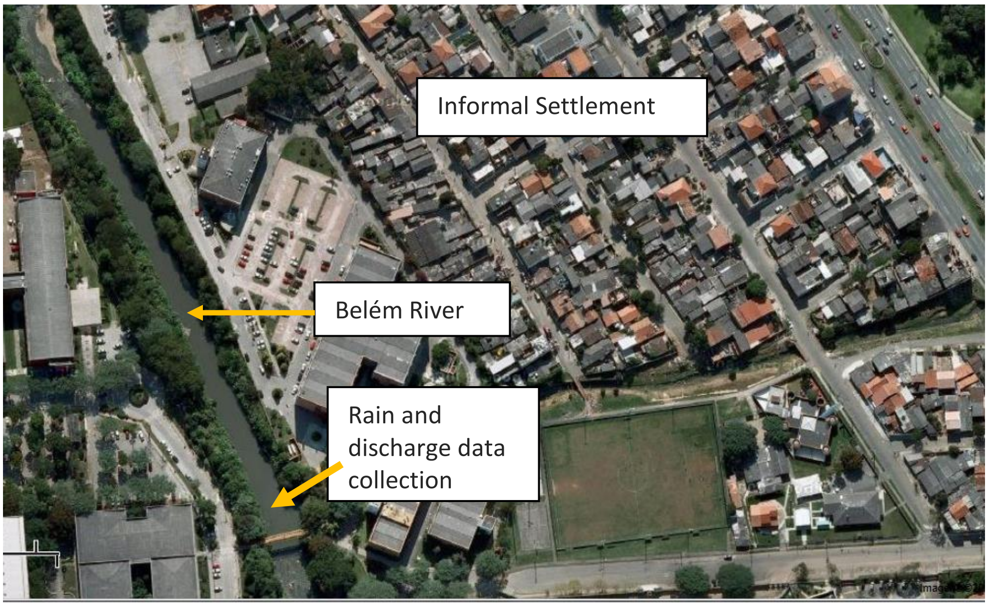
Natural hazards may occur regardless of social stratification, however, their impacts affect differently among these very same specificities, enabling damages to increase or diminish their temporalities. Empirical and scientific observations also confirm that lower income levels of the population are more affected by recurrent hazards, demanding an explicit consideration of social and economic parameters in the vulnerability concept. In fact, it is now largely accepted that similar exposures to natural hazards may generate different consequences according to social and economic specificities of a certain population. By adding complex social layers to a wide concept such as Beck's (1992, 2006) risk society, vulnerability would so act as a result of contemporary economic and technological development but also of discrepancies in the outputs distribution of this very same development. Other concepts have so been rediscussed, but instead of eliminating preterit hegemonic ways of understanding natural disasters impacts, they were adjusted in new and more complex hierarchies of importance. This article is based on such conceptual bias, stressing a close relation between impacts caused by natural disasters and social characteristics of those who are submitted to them.

If causes of natural adversities are to be observed in a diversity of typologies, current scientific production seems to focus its main concern on the social factor, which is considered decisive to understand natural hazard impacts.

If impacts are now considered according to multiple perspectives (a long-desired comprehension), prevention still depends on a limited social memory. In fact, because of the fact that social vulnerability may be understood as a "dormant phenomenon in suspended animation till a calamity occurs," it is still more easily related to risk management situations and hardly taken as a pre-existing condition that shapes suffering and recovery ability. Although progress can be observed in scholar discussions on adverse phenomena - confirmed and fostered by an increasing scientific discussion on the theme -, public policies seem reluctant in taking new approaches in their programs leaving more fragile groups relying on their own community organizations. That was the situation observed by these authors in previous case studies concerning specific disasters in Brazil: government as well as population is heading to a complacent situation that leads people under risk to take their situation for granted.

Case study presented here discusses a mathematical model to reduce risks imposed to people living in improper areas, yet it does call for the need to think about structural changes and long-term planning: forecast is so considered an emergency action but not a definite solution. Case study takes place in the city of Curitiba, located in the southern region of Brazil, with 2 million. Despite the fact the city may sometimes be taken as an urban planning model, there still are resisting and deep social discrepancies long observed in its territory or metropolitan region. The urban compartment selected for this discussion is a section of the Belem River Basin, a river crossing north-south the entire city. Occupation of this area is characterized by low income families in illegal settlements as well as middle class formal settlements, some business activities and a large portion owned by a university campus.

Figure 1: City of Curitiba and Belem River Basin selected section: informal settlement along risk areas.



Source: Authors

The mathematical model used for the Belem River Basin aimed to validate a tool to predict floods with a minimum lapse of time making preparedness actions feasible. Methodology used is that of flood prediction by means of Classification Rules according to Liu et al., 1998. This warning system was developed by analyzing a daily rainfall and discharges series for the period between April, 1981 through August, 2011. This forecast model intends to offer local authorities (civil defense, fire brigades and other government institutions) a tool to allow prior action to flood events.

Considering the complexity involving the increasing number of accidents and the increasing impacts they impose, this paper concerns the need for cities to adopt 1. Planning tools for long-term prevention; 2. Public policies that view vulnerability as a phenomenon featured by social and spatial factors and so demanding for priorities to those who are most subject to risks; and 3. Forecast systems and techniques to proper take preparedness action due to difficulties to totally reverse improper occupations in risk areas. Context and conceptual basis of this article refers to these three concerns. Case study refers to the third one.

In the urban studies field, authors recurrently quote social system as an important fact to understand vulnerabilities related to natural hazards (Santos, 1998; Maricato, 1996; Rolnik, 1997, 2011; Giddens, 2000; Kasperson et al, 2001; Mattedi & Butzke, 2001; and Marandola Jr. & Hogan, 2008, among others with implicit or explicit but similar concerns). Again, although cities are both the cause and the scenario of devastating phenomena, studies carried by these authors in Brazilian cities attest not much progress in terms of local policies besides emergency traditional action.

Despite recent positive changes observed in Brazilian cities in terms of housing programs for low-income families and financial resources for urban basic infrastructure, larger parts of their population still face the impacts of historic deficits and urban land misuse. At the same time, large and well-intentioned social governmental programs may also generate externalities that aggravate long observed vulnerabilities. These programs, by recognizing social and financial limitations to transform entire cities, have channeled efforts to more pragmatic and risky solutions, implemented partial interventions, legalized squatted lots and kept dwellers in their original but sometimes still improper areas (Ultramari & Firkowski, 2012). Despite the fact that this approach may be considered appropriate if juxtaposed to scarcity of resources and to the emergency reality reveals, it does not fully eliminate the submission of this very same population to immediate impacts of natural disasters. Settlement taken as case study for this paper portrays the consequences of governmental actions like this: some rearrangements of its internal roads network, some basic infrastructure, some improvements in housing units, but almost no resettlements for families living along the river. This situation reinforces the importance of forecasts systems, designed to allow the permanence of original settlements in risk areas so far natural conditions indicate as applicable. Despite not yet popular in Brazil, such systems are already technically available, have already been tested and may be adapted to local specificities. That is a response one would like to consider temporary, therefore, due to the way Brazilian cities have been consolidated, with no easy answer to informal, non-planned and risk occupations, it seems not only adequate but perhaps one of the few solutions currently available.

Lack of new proper urban land is thus now a real problem. For the first time in recent large Brazilian cities history, limitations for implementing social housing programs concern not only financial restrictions and speculative behaviors but also physical unavailability of proper land. This new situation indicates a problem that has unexpectedly forced national urban planning and management to be more "flexible" in their parameters of proper and safe land. Irony now takes place in the construction and transformation of Brazilian cities: if, in the past, they experienced risks being concretized by illegal or informal occupation, at present, this phenomenon may take place because of official determination and technical orientation.

NATURAL HAZARDS AND VULNERABILITY

Situation previously described confirms thus the idea of a wider concept of vulnerability resulting from natural accidents. Certainly, social, community, political, cultural, and economic aspects play decisive roles in its definition side by side to natural phenomena. This is, in fact, a conceptual approach already largely adopted by the scientific milieu and that has been clearly defined by the distinction between the Theory of Disasters and the Theory of Hazards. In a first moment, this research may be considered much closer to the Theory of Disasters concepts, since it deals with a precise kind of natural adversity and develops as rationale to predict and quantify it prior to the event itself. However, this discussion is deeply rooted in the concerns of Hazards Theory, too. In fact, this research takes it as its main reference to understand urban occupation dynamics (presented above) as a fundamental factor to consider lower income levels of the population as the most vulnerable to natural disasters' effects. These populations, usually living in risk areas and relying on their low incomes to cope with adverse situations present a limited "response capacity". Alternatively, external governmental and non-governmental agents become the sole real possibility to mitigate impacts.

Urban social factors are generally taken as a very broad concept, but immediately reveal tangible aspects of the population in terms of financial conditions to respond positively to basic needs in cities. In fact, these are crucial aspects to define social vulnerability. At the same time, in the case of emergency situations other components enrich the idea of social characteristics. That is the case of governmental and non-governmental institutional frameworks available to provide emergency responses, implement recovery works and establish prevention procedures. Curitiba is an example of a city with different urban compartments according to their urban indicators, with specificities in terms of community ability to react when facing adverse phenomena but with a relatively homogeneous paid attention in terms of governmental public policy in preventive actions. This combination of factors confirms the complexity of the social vulnerability concept expected to be revealed in the city of Curitiba, as well as in other Brazilian cities if their sociospacial specificities are taken into consideration. Previous phase of the case study described here (Hummel, 2010) identified an overlay of a concentration of low social indicators and the number of natural accidents per district. This phase also confirmed that social indicators certainly have a close relation to the compulsory choice lower income communities are imposed when settling in the city. In Curitiba, as well as in other Brazilian medium and large cities, 1970-1990´s poor migrants were “offered” parcels of land once considered improper, both those cheaply or legally traded and those simply squatted. Among many others Brazilian authors, Rolnik (2011), perhaps synthesizes the best this situation: “… people live in a risk area because there is no other option to their income. We are talking about workers whose salary does not allow buying neither to rent a place to live in a proper area. …”

Such reality may be referred to the pressure and release model as announced by Blaikie et al (1994), reformulating what had been previously identified by Turner et al (2003). The model proposed by Turner et al (Risk Hazard Model) understands impact of hazards as a result of the exposure to a hazardous phenomenon and of the sensitivity of a community exposed; however, authors do not make clear what or how impacts of the hazard are amplified or attenuated. The model by Blaikie et al (1994) stresses the progression of vulnerability according to the relation between the four main components - three socially constructed and one naturally built: root causes, dynamic pressures, unsafe conditions, and the natural hazard itself. In the case of the city of Curitiba, these four components can be understood as follows:

1. Root causes can be translated into the economic and demographic features of the different districts in the city, each of them presenting specificities in their average income, unemployment rate, and demographic performance implied in the number of people per family and house density. Belem River Basin selected compartment is among those in the worst position.

2. Dynamic pressures may indicate the migration process observed in the city since the turn of the 19th century. Along time, to those arriving with lower salaries were left improper land, distant areas from the city center, or simply the squatting process. Belem River Basin is among the first areas to be squatted in the city, and, as a pattern for cases like this, paid no attention to its riparian preservation area.

3. Blaikie et al´s component for unsafe situations is to be observed mostly in summer time during the rainy season and the resulting floods: illegal settlements along rivers or in areas already considered improper by planning guidelines but still

an affordable choice for lower income classes are among the most submitted areas to such adversity. Again, that is the situation observed in the case study compartment.

4. Finally, in terms of the natural hazard itself - the fourth component -, it is important to recall that impermeabilization of urban land in the city resulting from a demographic rate of 1.3% per year and a never seem civil construction sector boom have imposed the elimination of so far large areas of natural permeability. The compartment studied here comprehends a total of 1000 families, in approximately 42 sq. kilometer, not fully legalized, resulting in an 80% impermeable area (technically very high for an area like this).

The consolidation of this illegal settlement implies a necessary submission to a deeply rooted reality. It indicates any serious important program to relocate people is feasible, forcing or justifying local government in pragmatic actions such as those of warning systems. At the same time, if the case of Belem Basin does not allow its entire relocation, it is absolutely necessary urban planning and management take more consistent and structural actions in terms of future land use and long-term tools.

Models to establish components of a comprehensive concept of vulnerability and indicators to geographically measure impacts of adverse phenomena are objects of recurrent practice, both at public policy agencies and scientific production levels, yet under constant criticism. Undoubtedly, despite conceptual limitations of these methodological tools, they remain, or should remain, a reference for public management concerning the necessary priority to the most sensitive groups in risk or emergency situations. That is the case of long term policies tailored to detect priorities in a limited territory. In the case of the city of Curitiba, as in many other Brazilian cities, lack of resources indicates the need to establish hierarchies in terms of who needs the most, who are in fact at risk and who are in fact more vulnerable to the risk than others. This approach would certainly not prioritize the compartment studied here as among those that with the lowest social indicators and recurrence of disasters. Therefore, the level of consolidation of its settlement makes it irreversible due to the number of families living there, to its strategic location in the city (2km from downtown district and among middle class and formal settlements) and to the high level of infrastructure and services, both private and public, already made available in the area. This is in fact a set of factors that justifies the pragmatism of accepting the irreversibility of an improper settlement, proposing a system that may confirm once more the occupation and providing only a reduction in the risk degree people currently face.

Justification is also guaranteed if other approaches towards natural disasters and social vulnerabilities are taken by the local government. That is the case of the establishment of planning guidelines not only to determine areas that should or should not be occupied, but equally the monitoring and surveyance to avoid new improper settlements and, above all, the determination of areas to be prioritized in terms of reurbanization actions. All these tools are determined by a set of indicators that synthesize 1. Social structures and processes (either by the lack of necessary infrastructure or by the occupation of environmentally fragile areas); 2. Different responses to recovery according to different socioeconomic profiles (poorest people rely more on immediate public action than those who can afford individualized solutions); and 3. Physical features of the municipal terrain (some areas are more subject to floods than others). The case of Curitiba, which could be taken as a parameter for other Brazilian cities, overlaps these three levels of comprehension: unsafe lands are primarily occupied by lower income people, both for historical reasons but mostly because of impositions of segregating practices concerning real estate values.

CASE STUDY: A TOOL FOR IMMEDIATE PUBLIC ACTION

Case study brought by this paper concerns immediate actions considering there are settlements in the city of Curitiba under recurrent adversities during intense rains season and with no substantial chance to be relocated to safer areas due to their level of urban consolidation expressed in high density, old constructed social bonds, availability of services and infrastructure and strategic location in the city.

The warning system proposed here follows the one elaborated by Fuqiang et al. (2002), already tested in Guangzhou, China. Basically, this model is designed to predict flooding and takes into consideration two variables: rain and runoff. The implementation of warning systems able to predict floods with high accuracy are fundamental tools on inundation risk management because they allow additional preparation prior to a catastrophe (Thiemig et al., 2011). Therefore, flood prediction is crucial for rescue operations performance, action on catastrophe mitigation and on environmental issues. Duncan et al. (2011), based on meteorological variables in mathematical models, describes a methodology which utilizes Artificial Neural Network (ANN) for urban flood prediction in real time. ANNs are nonlinear mapping systems whose construction is roughly based on principles observed in the nervous systems of animals and humans. The computational model is trained with meteorological radar data, rain gauges and discharge records in a network of culverts in the city of Keighley, UK. Similarly, Schellart et al. (2011, p.1), proposed the use of ANN for flood prediction and tested its accuracy in three other different places in UK: Pennine Hills in the North of England, the Cranbrook Catchment, in the London Borough of Redbridge, an area with a history of local flooding, and in the Stockbridge area of Keighley, West Yorkshire. The input data are meteorological radar data and rain gauges records. Case study presented here repeats similar techniques and reproduces similar situations of consolidated urban areas and with a cruel necessity to learn how to reconcile permanence and risks.

Flooding or overflow is characterized by a high discharge of superficial flow or runoff (Villela e Matos, 1975) when the water level exceeds the top of the river or channel edge. In order to predict flood occurrence is necessary to know the long term discharge or runoff distribution because it explains the flow increase induced by the rainfall until the end of the superficial flow. The evaluation of flood scenarios in this case study is based on rainfall, discharge and permanence data (a histogram of the discharges). These variables allow the construction of a model able to extrapolate critical conditions based on information not commonly available in historical data. The method used to predict flood 24 hours in advance is based on Classification Rules techniques. The classification is based on rules of kind (IF/THEN) or cause/effect and basically consists in discovering a small set of rules in a dataset which are able to define a class with high accuracy (Liu et al., 1998).

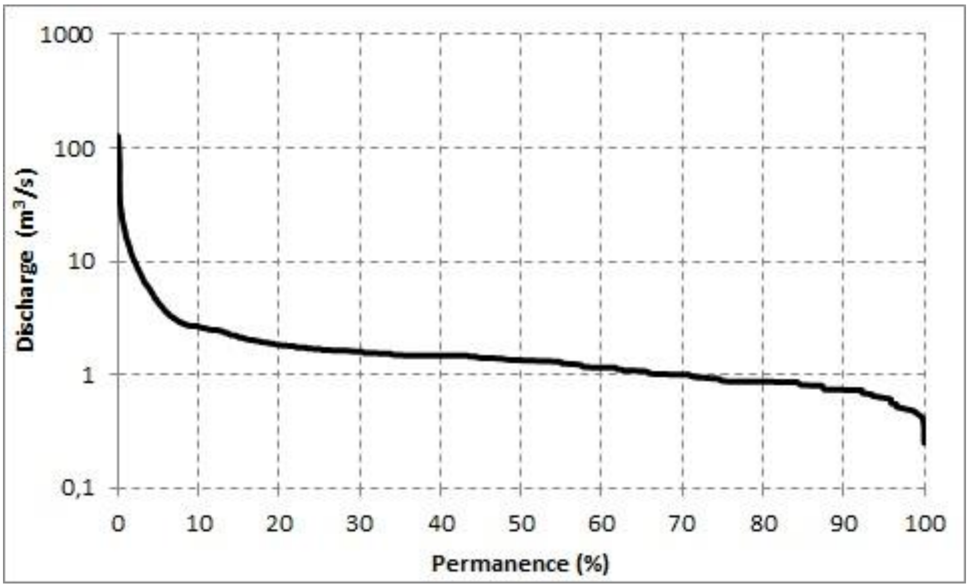
Methodology adopted here was developed in three steps. The first one in a data mining that aggregates the maximum amount of data related to the phenomenon studied. Data preparation is the second step and most important task in any data modeling strategy, as a carefully prepared dataset ensures that the information contained in it is accurate and relevant. In this step, inconsistencies (outliers, false zeros, missing values, etc) are resolved, data are selected according to their importance and the matrix for the predictive models is prepared. This matrix is constituted by the variables used in the analysis (rain, discharges and permanence). The third and last step is the modeling, when the prepared data are processed for the forecast model construction (Souza & Ebecken, 2012, Souza, 2013).

For the Belem River Basin section, 11,080 rain daily records were obtained. These records were collected from the rain gauge station located in the middle of the section crossing the basin selected area. The runoff or discharge data were acquired from the fluviometric station nearby the rain gauge with contributing drainage area of 42 km2 (Fendrich, 2002). These discharge data comprises average daily data from 1981 through 2011 and were collected from the HIDROWEB (2012), a platform managed by the Water National Agency (ANA).

The data comprises two attributes: daily rain (in mm) and daily average discharge (in m3/s). The output of the computational model is the prediction of the flood occurrence or non-occurrence for the next day (t+1 or “tomorrow”). A first approach considered as input variables the rain and discharge of the actual day (t0 or “today”). However, in this first approach the model accuracy was poor. The flood prediction system proposed by Corani and Guariso (2005) highlights the importance in considering a description of the soil saturation degree in the basin because the superficial flow depends on the infiltration rate over the time. For the case study presented here, such information was not available. This limitation was coped by using previous indicators of river flow rate occurred in days before, i.e., t-1 (“yesterday”), t-2, t-3, until t-19 were created. In addition, a new attribute was also inserted in the model from the permanence curve. A permanence curve is the discharge histogram in a 2D graph, as illustrated in Figure 2. The highest discharges have low permanence or low probability to occur because they depend on rare events that are the rainfall. For instance, the discharge of 10 m3/s has permanence lower than 5% of the time. Similarly, it can be observed that low discharge values have higher probability of occurrence or are more permanent because they are independent of rainfall. The value equal to 1.0 m3/s has permanence approximately to 70%.

At this moment, it is important to make clear what we consider a flood situation in the selected area. As the main purpose of the research is to test the computational performance of data in methodology for forecasting natural disasters, we took the decision to define flood by means of a proxy. On January, 23th, 2013, 6:30 pm, municipal emergency agencies detected what they considered flood, declaring state of alert for the need to remove families from the Belem river basin. At this time, river flow rate was 20 m3/s. This is the record we use to consider the existence of flood in the area. Flood level isolines would certainly increase accuracy, but they were not yet available at the moment we made the tests.

Figure 2: Belem River Permanence Curve (study area).

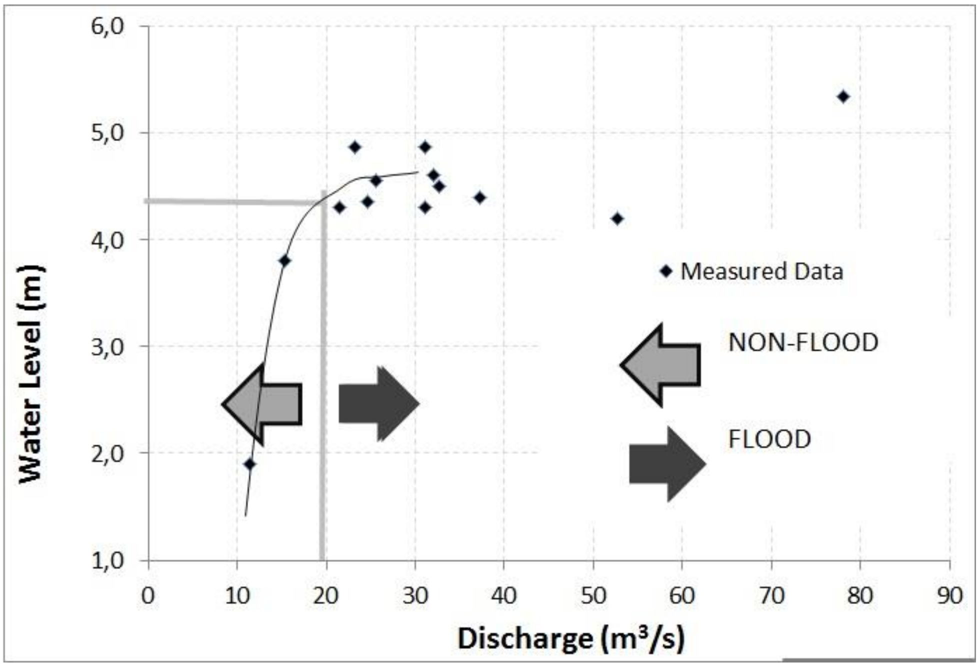


Source: Authors

The permanence curve reflects in some way the soil saturation degree and contributes for the model performance. For each of the three attributes (rain, discharge and permanence) 19 new variables considering 20 days before (t0 to t-19) the prediction day (t+1) were created. Moreover, three more variables from the discharge and permanence registers considering the minimum, average and maximum values for the 20-day interval and two more variables from the rain (average and maximum) were created. A new matrix with 68 input variables and one output variable was constructed.

The definition of the limit value for flood occurrence was obtained from the discharge curve. The discharge curve is a 2D graphic which relates the water level values in the ordinate axis and the discharge values in the abscissa axis. The discharge curve for the Belem River was constructed by considering measurements for high values between 1981 and 1997 (Fendrich, 2012), as illustrated in Figure 3. It can thus be agreed that the maximum water level prior to a flood is about 4,30 m or the altitude 882,69 m (from the sea level). The correspondent discharge for the flood level is about 20 m3/s, i.e., discharges values higher than 20 m3/s can induce flood. In this sense, the output variable values (t+1 or “tomorrow”) was transformed into two categories (Flood for discharge values over 20 m3/s and Non-Flood for discharge values equal or lower than 20 m3/s).

Figure 3. Belem River Discharge Curve (study area).



Source: Authors

RESULTS AND DISCUSSION

There are only 65 records (out of a total of 11080) in which the discharge values are higher than 20 m3/s. Thereby, a matrix with 130 registers including those 65 records with discharge values higher than 20 m3/s and other 65 registers with high values of discharges - lower than but very near to 20 m3/s - was built. This strategy in presenting to the model a confuse and difficult zone for deciding between the two classes intends to optimize learning process.

A model to predict flood 24 hours in advance by means of classification rules techniques with a 5% minimum support and 85% minimum confidence equals 85% was built. This “classifier” contains 22 rules like the example (Rule 1). If the rain 10 days before was lower than 3.5 mm, the discharge 19 days before was lower than 1m/s, the rain one-day before was between 0.8 and 7 mm, a flood occurs. In 12 times the previous part of the rule (cause) occurred, 12 times the flood occurred (consequence).

Rule 1: IF Rain_t10_<_3_5

Discharge_t19_<_1

0_8_<_Rain_t1_<_7

Then -> Class = Flood

(9.231% 100.000% 12 12 9.231%)

The result of a classifier model is usually shown in a form of a confusion matrix, as illustrated in Table 1.

Table 1: Confusion Matrix for Flood or Non-Flood classification.

	FLOOD	NON-FLOOD
Flood	63	2
Non-Flood	4	61

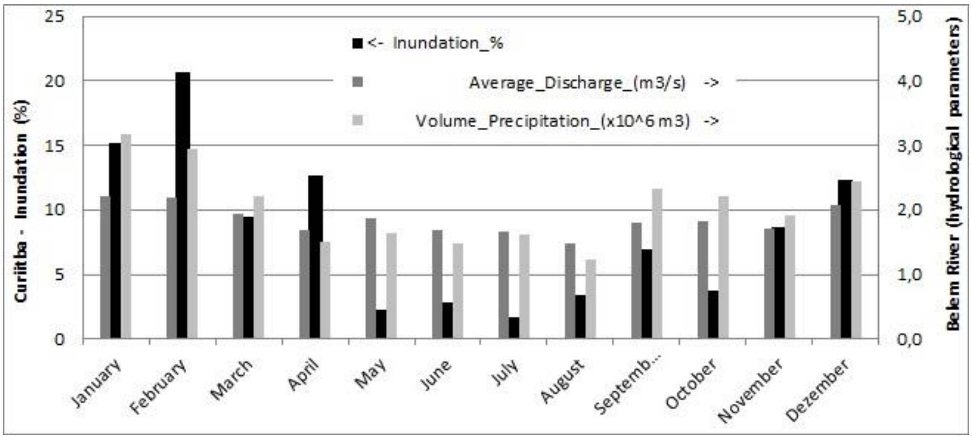
Source: Authors

The components of the main diagonal are the number in which the model has correctly classified or attributed the correct class for the analyzed object (Flood or Non-Flood). For the class Flood 61 examples were correctly classified and for the Non-Flood class 61 examples (4 and 2 are the number of samples in which the model errantly attributed the class). Therefore, the correct classification rate (CCR) of this model is (63+61=124) divided by the total number of samples (63+61+4+2=130). Therefore, the CCR is 95,4% which can be considered as a very high number due to the complexity involved in flood study.

The model accuracy could still be improved by adding new variables (soil characteristics for example) and/or by mathematical artifices on the model building such as Bagging techniques (Han and Kamber, 2001), Weighting (Duda, 2001), and Boosting (Ting and Zheng, 1998).

Flood prediction is a complex and difficult task and involves a huge number of taxonomies (climatological, atmospheric, soil use, topography, draining system density etc). The proposed predictive model in this work was built by using only two attributes (rain and discharge) and presented high accuracy with a CCR higher than 95%. Thereby, results obtained here intend to stress the importance of these tools in forecasting floods in the Belem River as well as in other basins of the city of Curitiba. Figure 4 shows a strong correlation between hydrological parameters (rain and discharge) measured in the Belem River basin and the percentage of inundation in the whole city of Curitiba for the 2005 – 2012 period. This situation confirms the possibility to replicate methodology and extrapolate results obtained here for the selected basin in the entire territory of the city of Curitiba.

Figure 4: Monthly inundation distribution in Curitiba vs. hydrological parameters in the Belem River basin.



Source: Authors

Expertise in flood occurrence and its forecast can certainly contribute to the reduction of human and economic losses in situations such as those described here for the city of Curitiba. Its computational tools could additionally be applied in other urban planning and management domains. The model presented here reinforces its potential for urban planning and management and may also suggest parameters for future definite solutions in reurbanization projects.

FINAL REMARKS

A conceptual review on social vulnerability and efforts to measure it were discussed in this paper with the purpose to confirm the importance we give to the definition of priorities in public policies and to the need of deep changes in the way cities are occupied. Both concerns reveal an interest in structural and lasting changes in Brazilian cities. However, a long misuse of urban land process as well as a permissive administration led to wrongly consolidated urban compartments or even entire cities. Such scenario calls for immediate action even if they signalize for no long-term change. Adoption of warning systems was presented here as an imposed alternative by both the difficulties to relocate improper settlements and to the need to reduce or mitigate adverse events impacts on communities already waiting for the fulfilment of other basic urban demands.

Despite the confirmed possibility to rely on the prediction of floods as a parameter for the development of public policies in the city of Curitiba, it leaves room for controversies concerning the availability of data in other cities and, what is much more important, to its possible implication in making improper settlements irreversibility stronger.

However, methodology used in this case study may constitute a simple and low-cost tool not only for emergency predictions in selected areas but also for establishing parameters to reformulate land use legislations. In this case, other taxonomies should be added but main procedures are maintained. Considering rain seasons floods as the most recurrent natural disaster in Brazilian cities and the low specificity of Curitiba among a larger urban context, we believe this methodology can be replicated in other situations of the country.

If the assumption that different socioeconomic levels are affected differently by natural hazards is largely taken into consideration at conceptual discussion, urban management practices are hardly familiarized with this particularities in their own territories. It draws the attention to the fact that preventive actions are not only needed but also must adopt a profound fractal vision of the city.

The pragmatic understanding that we complacently identify risk areas in our cities with no indication to be fully transformed, neither their populations properly removed, forces us to elaborate emergency policies; that is precisely the methodology described above.

REFERENCES

BECK, U. **Risk Society**: Towards a New Modernity. London, Sage Publications, 1992.

______, Ulrich. Living In the World Risk Society. **British Journal of Sociology Centennial Professor**. London School of Economics and Political Science: A Hobhouse Memorial Public Lecture given on Wednesday 15th February 2006, London, 2006.

BLAIKIE, Piers et al. At risk. **Natural hazards, people's vulnerability and disasters**, 1994.

CORANI, G., GUARISO, G. Coupling Fuzzy Modeling and Neural Networks for River Flood Prediction. **IEEE Transactions on Systems, Man, and Cybernetics** – Part C: Applications and reviews, vol. 35, no. 3, August, 2005.

DUDA, R. O., HART, P. E., STORK, D. G. **Pattern Classification, Wiley Interscience**, Second Edition, 2001.

DUNCAN, A. P. *et al*. Urban flood prediction in real-time from weather radar and rainfall data using artificial neural networks. **Weather Radar and Hydrology**. (Proceedings of a symposium held in Exeter, UK, April) (IAHS Publ. 351, 2012), 568-573, 2011.

FENDRICH, R. Relação de "Permeabilidade Artificial" dos solos "Rp" de uma bacia hidrográfica urbana: detenção distribuída das águas pluviais. **Revista Técnica do IEP**. Ano II, no. 4, Jan/Jun, PP. 5-14, 2012.

______. **Diagnóstico dos recursos hídricos da Bacia Hidrográfica do Rio Belém**, 2002.

______. **Bacia Hidrográfica Urbana do Rio Belém**. INTEC/PUCPR, Curitiba, 1997.

FUQIANG, T., HEPING, H., JIANZHONG, G.. An Urban Flood Simulation Model based on Geographic Information System. International Commission on Irrigation and Drainage. **Eighteenth Congress**. Montreal. Q. 51. P. 3.05, 2002.

GIDDENS, Anthony. **Sociologia**. 2. ed. Lisboa: Fundação Calouste Gulbenkian, 200.

HAN, J., KAMBER, H. **Data Mining - Concepts and Techniques** – Chapters 6, 7 and 8, 2001

HUMMELL, Beatriz. **Vulnerability Indexes in the city of Curitiba**: an overlay of poverty and natural disasters. Master dissertation (Pontifical Catholic University of Parana), PPGTU Program, 2010.

KASPERSON, R. E.; KASPERSON, J. X; DOW, K. 2001. Vulnerability, equity, and global environment change. In: Kasperson, R. E; K., Jeanne X. (Ed.). **Global Environmental Risk**. Londres: United Nations University Press, p.247-272.

LIU, B., HSU, W., CHEN, S., MA, Y., 1998. **Integrating Classification and Association Rule Mining**, KDD-98, August, New York.

MARANDOLA Jr., E.; HOGAN, D. J. 2008. **As dimensões da vulnerabilidade**. São Paulo em Perspectiva, São Paulo, Fundação Seade, v. 20, n. 1, p. 33-43, jan./mar. 2006. Available at <http://www.scielo.br>. [Accessed 3 August, 2010].

_______. Natural Hazards: o estudo geográfico dos riscos e perigos. **Revista Ambiente & Sociedade**. v. 7, n. 2, jul/dez, 2004.

MARICATO, E. **Metrópole na periferia do capitalismo**: desigualdade, ilegalidade e violência. São Paulo: Hucitec, 1996.

MATTEDI, M. A.; BUTZKE I. C. A relação entre o social e o natural nas abordagens de hazards e de desastres. **Revista Ambiente & Sociedade**, n.9 Campinas Jul. / Dez. 2001.

ROLNIK, R. **A cidade e a lei**: legislação, política urbana e territórios na cidade de São Paulo. São Paulo: Nobel/Fapesp, 1997.

______. Ninguém vai morar em área de risco porque quer ou porque é burro. **Jornal Brasil de Fato**, Jan., 14th, 2011. Available at <http://www.brasildefato.com.br/node/5475>. Accessed: 5 Nov, 2011.

SANTOS, Milton; SOUZA, Maria Adélia de; SILVEIRA, Maria Laura. **Território**: globalização e fragmentação. Hucitec: São Paulo, 1998.

SOUZA, F.T., Ebecken, N., 2012. A Data Based Model to Predict Landslide Induced by Rainfall in Rio de Janeiro City. **Geotechnical and Geological Engineering**. 30, 85-94.

SOUZA, F.T., 2013. A data-based model to locate mass movements triggered by seismic events in Sichuan, China. **Environmental Monitoring and Assessment**.

SCHELLART, A. *et al*. **Urban pluvial flood modelling with real time rainfall information** – UK case studies. 12nd International Conference on Urban Drainage, Porto Alegre, 10-15, September 1, 2011.

THIEMIG, V., ROO, A., GADAIN, H. Current status on flood forecasting and early warning in Africa, **International Journal of River Basin Management**, 9:1, 63-78, 2011.

TING, K. M., ZHENG, Z. "Boosting Trees for Cost-Sensitive Classifications", **Proceedings of the 10th European Conference on Machine Learning**, LNAI-1398, Berlin: Springer-Verlag, pp. 190-195, 1998.

TURNER, B. L., *et al*. **Science and Technology for Sustainable Development Special Feature**: A framework for vulnerability analysis in sustainability science. PNAS 100(14): 8074-8079, 2003a.

ULTRAMARI, Clovis; FIRKOWSKI, Olga L. C. F. Sobre mudanças e continuidades na Gestão Urbana Brasileira. **Mercator (Fortaleza. Online),** v. 1, p. 73-88, 2012).

VILLELA, S. M. & MATOS, A., 1975. **Hidrologia Aplicada**. Editora McGraw-Hill, São Paulo.

ZHANG et al., 2012. Integrating an Agent-Based Travel Behavior Model with Large-Scale Microscopic Traffic Simulation for Corridor-Level and Sub-Area Transportation Operations and Planning Applications. **Journal of Urban Planning and Development**, 139(2), 94–103.

Recebido: 04 mar. 2017.
Aprovado: 24 jun. 2017.
DOI: 10.3895/rts.v14n30.5632
Como citar: SOUZA, F. T. de; ULTRAMARI, C; HUMMELL, B. A pragmatic acceptance of short term policies: the case of floodings in Curitiba, Brasil. **R. Tecnol. Soc.** v. 14, n. 30, p. 202-216, jan./abr. 2018. Disponível em: <https://periodicos.utfpr.edu.br/rts/article/view/5632>. Acesso em: XXX.
Correspondência:
Fabio Teodoro de Souza
Pontifical Catholic University of Paraná (PUCPR) - Postgraduate Program in Urban Management (PPGTU)
Polytechnic School and School of Architecture and Design Rua Imaculada Conceição—1155-Prado Velho, Po Box: 16210, 80215-90, Curitiba, Paraná, Brazil