



Universidade Federal do Rio de Janeiro

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**SUPPORT FOR PLAN ADAPTATION IN
UNFORESEEN COMPLEX SITUATIONS**

DOCTORAL THESIS

Rio de Janeiro



Instituto Tércio Pacitti de Aplicações
e Pesquisas Computacionais

UNIVERSIDADE FEDERAL DO RIO DE JANEIRO
INSTITUTO DE MATEMÁTICA
INSTITUTO TÉRCIO PACITTI DE APLICAÇÕES E PESQUISAS COMPUTACIONAIS
PROGRAMA DE PÓS-GRADUAÇÃO EM INFORMÁTICA

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SUPPORT FOR PLAN ADAPTATION IN UNFORESEEN COMPLEX SITUATIONS

Doctoral thesis submitted to the Programa de Pós-Graduação em Informática, Instituto de Matemática e Instituto Tércio Pacitti, Universidade Federal do Rio de Janeiro as a partial requirement to obtain the title of Doctor in Informatics.

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Rio de Janeiro
2016

S586s Silva, Bruna Diirr Gonçalves da
Support for Plan Adaptation in Unforeseen
Complex Situation / Bruna Diirr Gonçalves da Silva.
- Rio de Janeiro, 2016.
179 f.

Orientador: Marcos Roberto da Silva Borges.
Coorientador: David Joseph Mendonça.
Tese (doutorado) - Universidade Federal do Rio
de Janeiro, Instituto Tércio Pacitti de Aplicações e
Pesquisas Computacionais, Programa de Pós-Graduação
em informática, 2016.

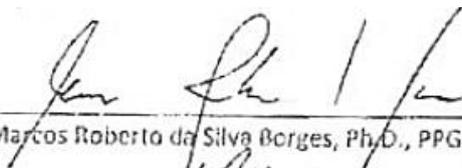
1. Unforeseen situations. 2. Plans. 3. On-the
fly adaptation. 4. Knowledge management. 5.
Improvisation. I. Borges, Marcos Roberto da Silva,
orient. II. Mendonça, David Joseph, coorient. III.
Título.

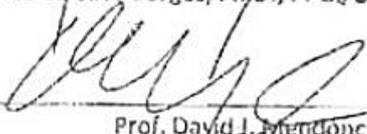
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Tese de Doutorado apresentada ao Programa de Pós-Graduação em Informática, Instituto de Matemática e Instituto Tércio Pacitti, Universidade Federal do Rio de Janeiro, como requisito parcial à obtenção do título de Doutor em Informática.

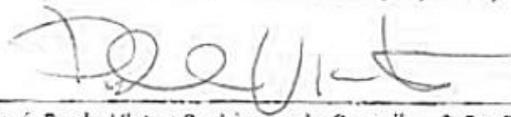
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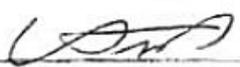

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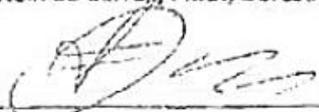

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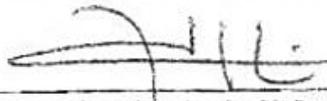
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Prof. José Fl. Canós, Ph.D., DSIC/UPV

Acknowledgements

First, I thank God and all spiritual guides who always led my way to great opportunities, even in tortuous ways sometimes.

To my beloved parents, Maria da Penha and Cesar, who taught me the love of learning and encouraged me to always achieve my goals by farther than they could be. Thank you for the encouragement, understanding, and sermons when everything seemed to go wrong. You were always there, even knowing nothing about the subject. You will always be there.

To my beloved Tiago, who was present throughout this journey, from undergraduate to PhD., holding on in complicated times and always encouraging me to move on. Many times, everything seemed to go wrong, but you showed me that with perseverance we can achieve good results. Thank you for being by my side, listening, criticizing, suggesting, coding.

To my dear advisor Marcos, for his help, availability and dedication during this thesis development. Thanks for the encouragement, advertences, research opportunities and social interaction provided. It has helped to develop and enhance my research and myself. If today world has another researcher, you can be sure that it is the result of your work.

To my co-advisor David, who received me at RPI during seven months, offering his time to contribute to my research from a different perspective. All discussions and materials helped to enhance this thesis. In addition, the interaction with a different academic environment also contributed to my development as a researcher and as a person.

To my dear friends, who have heard my anxieties, problems, discoveries and achievements in bar tables, papers writing and/or conferences. In particular, Viviane, Bruno, Kelli, Cassia, Luana and Alan who were going through the same afflictions during their Ph.D. and always encouraged me.

To my PPGI colleagues, teachers and students, who provided a knowledge and experience exchange environment. Thanks to complementing my knowledge, open my horizons, and encourage and support me during presentations in seminars and congresses.

To the undergrad student Pedro Moya, who spent his time building the computational support. I hope I have taught you as much as I have learned.

To the domain professionals, Cristiane, Thiago, Walter, Rodrigo, Leandro, Airton, Wallace, and to the experiment participants. Without these people's cooperation, few things could have been done in this research.

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) by scholarships (PhD and Sandwich).

To the members of the board, for showing new perspectives about the researched topic and contributing to this thesis improvement.

Finally, I thank those who have allowed my professional journey to reach this point and I may have forgotten to mention here.

“Happens every day. We rehearse a thing beforehand in our own minds, it doesn't matter what it is, consultation with another practitioner, proposal of marriage to a young lady, talk with your boy before going back to school - when the thing comes off, it never goes as you thought it would. You've thought it out, you see; all the things that you are going to say and you've usually made up your mind what the answers are going to be. And, of course, that's what throws you off every time. The answers never are what you think they will be.”

Ordeal by Innocence
Agatha Christie

Resumo

SILVA, Bruna Diirr Gonçalves da. **Support for plan adaptation in unforeseen complex situations**. 2016. pp. 179 f. Tese (Doutorado em Informática) – Instituto de Matemática, Instituto Tércio Pacitti de Aplicações e Pesquisas Computacionais, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.

As pessoas e organizações precisam lidar com diferentes fenômenos, que variam desde a total organização e controle até o caos e descontrole, para atingir seus objetivos. Quanto mais próximo um fenômeno está do extremo em que é possível garantir certa organização e controle, mais facilitado é o seu planejamento prévio e tratamento. À medida em que se afasta desse extremo, novas dificuldades são impostas e o planejamento e tratamento se tornam mais difíceis.

Apesar de usuais, não é trivial identificar mecanismos que possibilitem o tratamento de fenômenos irregulares, onde não se tem conhecimento total de seus detalhes previamente, comumente são enfrentados eventos imprevistos e é requerido criatividade na execução de ações e tomadas de decisão durante o tratamento. A variedade de opções e suas combinações podem gerar uma série de alternativas difíceis de serem elencadas em tempo de planejamento. Além disso, as características imprevisíveis e incertas do ambiente revelam novas variáveis e eventos não previstos apenas em tempo de execução. As decisões e ações realizadas durante o tratamento também afetam a situação observada, fazendo com que as equipes de resposta enfrentem estados não planejados. Mais do que isso, mesmo para as situações previstas, podem ser identificados resultados diferentes dos esperados quando as ações planejadas são aplicadas. Assim, é possível notar que tais fenômenos propiciam a ocorrência de situações imprevistas, isto é, condições onde a evolução esperada da situação não corresponde à evolução observada na realidade. Isso faz com que o plano existente se torne inadequado a ser aplicado.

O objetivo geral da tese é auxiliar as equipes de resposta no diagnóstico de situações imprevistas e realização de ajustes durante a execução do plano escolhido. É proposta a abordagem para adaptação *on-the-fly* do plano utilizando conhecimento explícito e tácito sobre o fenômeno. Ela envolve o monitoramento do plano selecionado, considerando a situação observada do fenômeno e um conjunto de parâmetros pré-estabelecidos, para avaliar se o plano desenvolvido previamente ainda pode ser aplicado ou se alguma situação imprevista foi identificada. Em caso positivo, a situação imprevista é interpretada para determinar se a mesma produziu uma *disruption* no plano, isto é, um problema que dificulta o plano prosseguir da forma como esperado. Quando uma *disruption* ocorre, a adaptação do plano permite a geração e seleção de soluções alternativas para a mesma, que devem ser aplicadas durante o tratamento. Argumenta-se que a abordagem proposta provê um tratamento mais sistemático das situações imprevistas, além de um maior apoio à tomada de decisão, ao lidar com a adaptação *on-the-fly* de planos em ambientes complexos. Ela oferece

mecanismos que auxiliam o diagnóstico e tratamento de eventuais situações imprevistas, fazendo com que o plano se torne mais aderente à realidade atual e seja efetivo para o tratamento do mesmo.

A avaliação da abordagem proposta é feita utilizando o domínio de gestão de emergências. Sustenta-se que os questionamentos, experimentações e análises realizadas nesse domínio permitem observar o impacto da aplicação da proposta e chegar a conclusões que podem ser aplicadas, expandidas ou generalizadas a outros domínios complexos com características semelhantes. Os resultados iniciais dessa avaliação indicam a viabilidade da proposta para lidar com situações imprevistas ao enfrentar fenômenos irregulares em ambientes complexos.

Palavras-chave: Situações imprevistas. Planos. Adaptação *on-the-fly*. Gestão do conhecimento. Improvisação.

Abstract

SILVA, Bruna Diirr Gonçalves da. **Support for plan adaptation in unforeseen complex situations**. 2016. pp. 179 f. Thesis (Ph.D. in Informatics) – Instituto de Matemática, Instituto Tércio Pacitti de Aplicações e Pesquisas Computacionais, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.

People and organizations deal with different phenomena, ranging from total organization and control to chaos, to achieve their goals. Handling phenomena closer to the extreme in which it is possible to ensure organization and control makes prior planning and treatment easier. As we move away from this extreme, new difficulties are imposed and the planning and handling activities become more difficult.

Although usual, it is not trivial to find mechanisms for handling irregular phenomena, which do not show their details in advance, commonly face unpredicted events, and require creativity in performing actions and decision-making during treatment. The variety of options and their combination may generate several alternatives difficult to deal with at planning time. In addition, the unpredictable and uncertain characteristics of the environment reveal new variables and unexpected events only at enactment time. Decisions and actions performed during handling also affect the observed situation, leading the response team towards facing unplanned or unpredictable states. More than that, even for known situations, not all possible outcomes can be identified. Thus, such phenomena enable the occurrence of unforeseen situations, i.e., conditions where the expected situation evolution does not correspond to the evolution observed in reality. It makes the existing plan becomes inappropriate to be applied.

The overall aim of the thesis is to assist the response team in diagnosing unforeseen situations and adjusting prior developed plans at runtime. An approach for on-the-fly adaptation of plans by using explicit and tacit knowledge about the phenomenon is proposed. It involves monitoring the selected plan, considering the phenomenon observed situation and a set of predefined parameters, to assess if the prior developed plan can still be applied or some unforeseen situation was identified. If so, the unforeseen situation is interpreted to decide if it has caused a disruption in the plan, i.e., a problem that makes more difficult to apply the plan as expected. When a disruption occurs, the plan adaptation allows devising and selecting an alternative treatment for the disruption faced, which must be applied during handling. It is claimed that the thesis approach provides a more systematic way to handle unforeseen situations, besides a wider support to decision-making, when handling an on-the-fly adaptation of plans in complex environments. It provides mechanisms that support the diagnosis and treatment of unforeseen situations, making the plan adherent to the current reality and effective for the phenomenon handling.

The proposed approach evaluation uses the emergency management domain. It is argued that inquiries, experiments and analysis in this domain allow to observe the proposal

impact and to reach conclusions that may be applied, expanded or generalized to other similar complex domains. Initial results indicate the feasibility of the proposal to deal with unforeseen situations while handling irregular phenomena in complex environments.

Keywords: Unforeseen situations. Plans. On-the-fly adaptation. Knowledge management. Improvisation.

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1 Introduction

1.1 Motivation

In a complex, dynamic and unpredictable world, people and organizations must be prepared to handle different phenomena¹ (Figure 1-1). These phenomena may range from regular phenomena, where there are a certain organization and control being easier to identify the details of what may happen, to irregular phenomena, where a definition of what will occur is not clear (COURTNEY, 2001; KEMSLEY, 2011; WESTRUM, 2006).

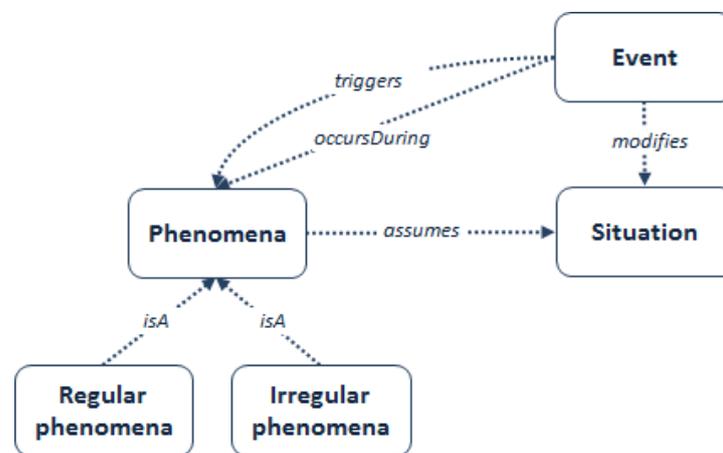


Figure 1-1: Conceptual description for phenomena

In the extreme where it is possible to establish certain organization and control, it is easier to identify, in advance, all possible events that may occur and detail the situations assumed during phenomena. The regular phenomena count on well-defined premises, variables and phases to achieve the desired goals and outcomes. In addition, as there is a specific and detailed pattern, a previous planning and repeated execution is easily accomplished. Moreover, all possible situations can be identified in advance, which enables planning alternative actions to be followed during the execution (HAMACHER; RAMDAS, 2011; SWENSON, 2010; WESTRUM, 2006). Examples of regular phenomena are purchases at online stores, equipment assembly on production lines, flights check-in etc.

¹ Definitions of all terms used throughout the thesis are found in Glossary section. This section aims to standardize the understanding of the adopted terms since there is no consensus about them.

As we move away from this extreme, phenomena become less systematized and more complex. In irregular phenomena, it is also possible to identify a set of premises, variables and phases to achieve the desired goals and outcomes. However, the level of organization and control are not the same as in regular phenomena. It is faced a greater level of dynamism, unpredictability and uncertainty that may lead to the identification of new events only at runtime. Planning cannot be entirely detailed since the variety of options and their combinations may generate several situations, which are difficult to detail in advance. In addition, creativity and improvisation are necessary to identify an alternative treatment when the prior planning become inadequate (HAMACHER; HOFSTEDE; POWER, 2002; RAMDAS, 2011; SWENSON, 2010; WESTRUM, 2006). Education, medical care, lawsuits and emergency management are examples of domains where these phenomena can be found.

When reaching the extreme of chaos and lack of control, it is usual that a prior model for handling the irregular phenomena cannot be developed since the environment constantly faces events that are new, unknown, unexpected and different from the usual. It inhibits an advance planning and makes difficult to predict all possible situations that may happen, as in epidemiological phenomena, climatic phenomena and economic movements. Thus, it is necessary more creativity and improvisation to identify alternative treatments during the phenomenon handling (HAMACHER; HOFSTEDE; POWER, 2002; WESTRUM, 2006).

Therefore, as closer as a phenomenon is from the extreme that it is possible to ensure organization and control, its treatment is easier. As we move away from this extreme, new difficulties are imposed, and planning and handling activities become more difficult and non-trivial. Irregular phenomena often have subjective and tacit definitions; possess dynamic execution; require creativity in execution and decision-making; face unexpected restrictions; generate unpredictable decisions; and evolve based on experience gained by the response teams. Although these phenomena are usual, the identification of mechanisms that allow planning and handling them is not a trivial task (DE MAN, 2009; FRANKE et al., 2010; LAKSHMANAN et al., 2012; RICHTER-VON HAGEN et al., 2005; SWENSON, 2010; WHITE, 2009).

1.2 Problem statement

The present research focuses on irregular phenomena (Figure 1-2). While planning alternatives for handling these phenomena, a planning team tries to devise a plan that details the different events that may be faced and describe what should be done while handling a

specific expected situation (HADDOW et al., 2011; PENADÉS et al., 2011). However, this task can be hard. The planning team identifies premises, variables and phases to achieve the desired goals and outcomes, but the lack of knowledge about the irregular phenomenon details makes difficult to generate a plan that specifies well-defined procedures to address all contingencies that may arise during its evolution (observed situation). It is common that the planning team does not consider all possible events that may happen because it must handle a wide variety of options and their combinations. This simplification makes difficult to detail all possible situations in advance. In addition, the planning team may decide to leave out a specific situation in the developed plan, even if its occurrence is possible, either because it is necessary to simplify the plan or because the occurrence of such situation may be rare. Moreover, the planning team may provide an inadequate treatment for a specific event, either because the situation caused by its occurrence has never been experienced or because of the unpredictability and uncertainty associated with it (GIL, 2015; HADDOW et al., 2011; PENADÉS et al., 2011. RAMIREZ et al., 2012; SAWYER et al., 2010; SYKES et al., 2013).

During phenomena handling, the use of a prior developed plan is not always straightforward (ALEXANDROU et al., 2009; BARTHE-DELANOË et al., 2014; BÖHRINGER, 2010; GIL, 2015; LAKSHMANAN et al., 2012; LEY et al., 2014; MENDONÇA and WALLACE, 2007; SAWYER et al., 2010; SYKES et al., 2013). The lack of knowledge about the irregular phenomenon may lead to the discovery of new variables and unexpected events to handle only at enactment time. In addition, the decisions and actions performed also affect the observed situation, leading the response team towards facing unplanned states. Moreover, even for known situations, different outcomes may be identified when the planned actions are applied in this partially known environment.

Thus, these irregular phenomena are enabling environments for unforeseen situations occurrence. Such situations may arise due to the lack of knowledge during planning, the application of the planned actions during the phenomenon handling and/or by the occurrence of events that are not expected during the execution. As result, the prior developed plan becomes inappropriate to be applied. Thus, it is necessary to observe the operation conditions, identify the new set of goals to be achieved, use creativity and improvisation to identify alternative treatments and make decisions at runtime, to deal with the identified unforeseen situation and to handle the ongoing phenomenon (BARTHE-DELANOË et al., 2014; BÖHRINGER, 2010; LAKSHMANAN et al., 2012; LEY et al., 2014; MENDONÇA and WALLACE,

2007). All gathered information provides feedback about the phenomenon handling and may be used as input for a plan evaluation.

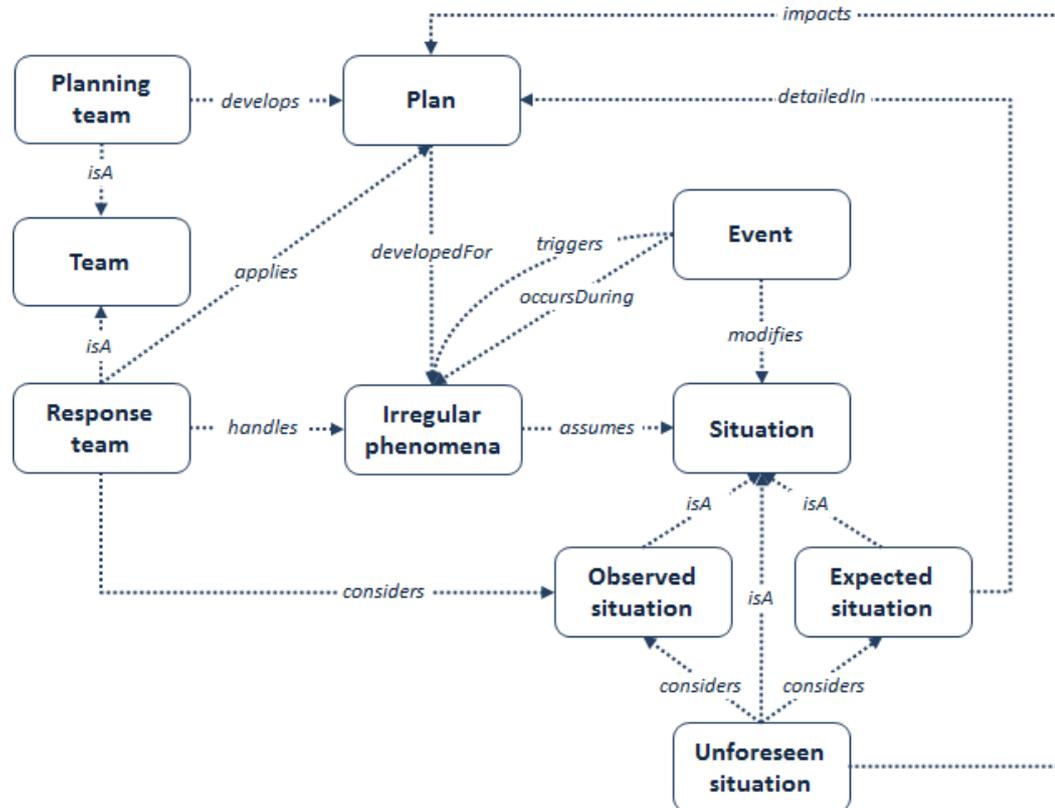


Figure 1-2: Conceptual description for irregular phenomena planning and handling

Given this context, it is possible to identify research opportunities in both planning, handling and evaluation activities in complex environments (Figure 1-3). Research on planning aims to design mechanisms to handle irregular phenomena (plan) that allow the definition or adaptation of these phenomena at runtime. This is necessary because it is not always possible to determine in detail how the irregular phenomena will evolve while being handled. Thus, it is necessary to propose ways (a) to describe these irregular phenomena, as defining meta-models for their representation, and (b) to facilitate plan adjustments at runtime, as devising plans that show points that require attention or are more likely to change during execution. Therefore, the response team may anticipate the need for adaptation and facilitate the inclusion of new actions to the existing plan.

Research on handling aims to apply, monitor and adjust a prior developed plan to the ongoing irregular phenomenon. It is necessary to propose mechanisms (a) to identify inputs that show a need for defining or implementing relevant changes in the plan and (b) to adjust the existing plan so it becomes suitable for handling the phenomenon observed situation.

Research on evaluation aims to collect information from phenomenon handling to have feedback about this irregular phenomenon and use the success and failures as input for the plan adjustment and evolution. With this, the planning team may provide a more suitable plan for handling future irregular phenomena.

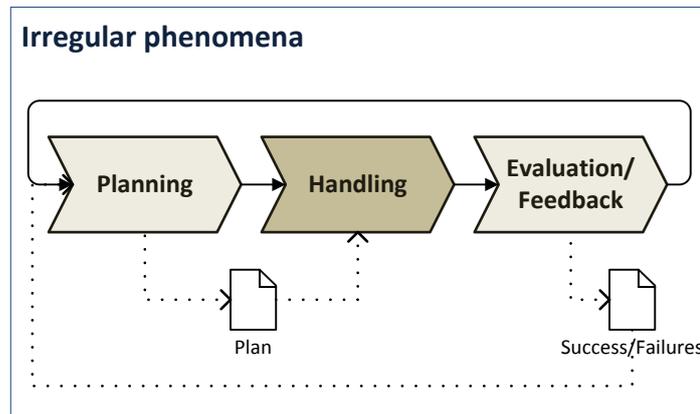


Figure 1-3: Research opportunities in irregular phenomena

This thesis focuses on the handling activity (Figure 1-3). Thus, considering this scope, the problem addressed by the present research is

the difficulty in diagnosing unforeseen situations and adjusting prior developed plans at runtime

The problem confirmation is important for the research continuity, thus interacting with groups who deal with unforeseen situations and adaptation of plans at runtime is necessary. Therefore, interviews with physicians and Civil Defense agents were carried out to confirm the problem existence, identify methods used to diagnose and handle, at runtime, events and situations that were not foreseen in the plan, and list the main difficulties faced while carrying out these tasks.

1.3 Solution approach

In complex environments, the real phenomena that need to be addressed become clear only during the phenomenon handling. The possible events and faced situations are presented at this point, which allows concluding the plan development. It is also possible to evaluate if the prior developed plan is still suitable for handling the phenomenon observed situation. If not, it is necessary to perform adaptations at runtime to adjust this plan.

The main goal of this thesis is to assist the response team in diagnosing unforeseen situations and making adjustments while a prior developed plan is being applied. For this, the thesis aims to provide mechanisms to support the identification of possible problems and the adaptation of the selected plan at runtime. Thus, to support the on-the-fly adaptation of plans when unforeseen situations occur, it is proposed the use of the knowledge arising from the phenomenon evolution (Figure 1-4). This knowledge can be identified from prior or current knowledge about the phenomenon, comprising (a) its observed situation, (b) plans, guides and reports describing prior handling, and (c) experience of teams involved while handling similar phenomena. It is claimed that the analysis of this knowledge allows a better understanding of the ongoing phenomenon and devising solutions that may inspire or be applied to the identified unforeseen situation.

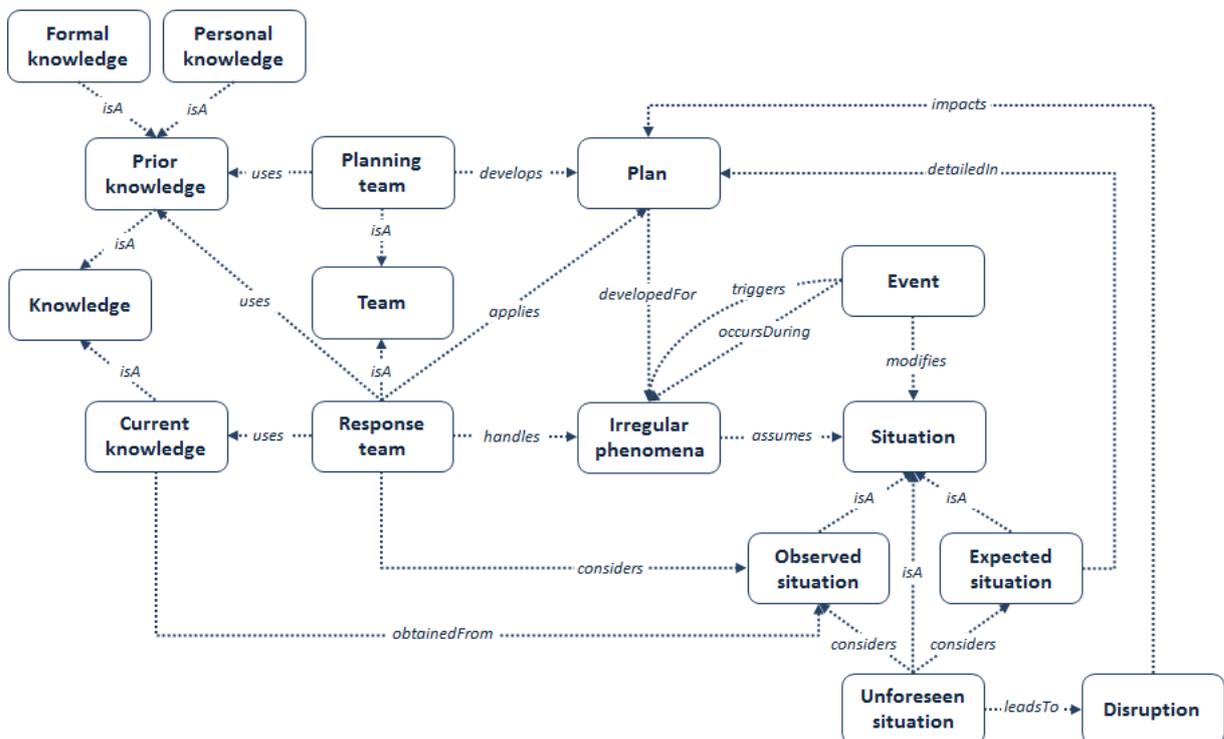


Figure 1-4: Conceptual description of knowledge arising from irregular phenomena evolution

1.4 Hypothesis

The hypothesis to be validated in the present research is

the use of the knowledge arising from the phenomenon evolution helps the on-the-fly adaptation of the existing plan when unforeseen situations occur

1.5 Proposed solution

It is proposed an approach for on-the-fly adaptation of plans when unforeseen situations occur (DIIRR et al, 2015). The approach supports decision-making by providing the response team with information and tools that allow identifying when the phenomenon observed situation does not correspond to the expected one, diagnosing the plan adequacy to handle this unforeseen situation and, if necessary, adjusting the plan to meet the current phenomenon evolution.

By **monitoring the selected plan**, considering the phenomenon observed situation and a set of pre-established parameters, the response team can establish a conformity degree between what was planned and what is happening. It allows assessing if the prior developed plan can still be applied or if any unforeseen situation has been identified and requires further analysis. If an unforeseen situation has occurred, the **interpretation of the unforeseen situation** is required. According to a set of criteria, it is possible to characterize the unforeseen situation and determine if it has produced a disruption in the plan. Disruptions indicate the need to adapt the selected plan. The **plan adaptation** allows devising and selecting alternative solutions to the identified disruption. The adapted plan should be applied during the phenomenon handling.

It is argued that the approach provides a more systematic way to handle unforeseen situations, besides a wider support to decision-making when dealing with on-the-fly adaptation of plans in complex environments. It provides mechanisms for using explicit and tacit knowledge about the irregular phenomenon to support the diagnosing and handling of unforeseen situations, making the plan become more suitable and effective for handling the real situation faced.

1.6 Methodology

At first, a characterization of the different types of phenomena that need to be addressed in complex environments was performed. From these phenomena, special attention was given to irregular phenomena. This decision was made because, although usual, the identification of mechanisms that allow handling these phenomena is not trivial. They also prove an enabling environment for unforeseen situations occurrence.

A literature review in conferences and journals allowed identifying methods used to diagnose and handle, at runtime, events and situations that were not foreseen in the plan,

and the main difficulties faced while carrying out these tasks. Interviews with physicians (DIIRR and BORGES, 2016) and Civil Defense agents provided extra information to the same end. Then, it was specified an approach that supports the diagnosis of unforeseen situations and performing adjustments in prior developed plans during their execution. The approach for on-the-fly adaptation of plans in unforeseen situations uses explicit and tacit knowledge about the phenomenon to identify unforeseen situations, interpret their impact on the existing plan and, if necessary, adapt the plan to address the problems identified. A tool was also specified and developed to support the approach application.

The proposed approach was firstly illustrated through its application in the Healthcare domain (DIIRR and BORGES, 2016), and then evaluated through an experiment in the emergency management domain. This domain was chosen because the situations discussed in this thesis are commonly identified, and it is considered a complex domain, more complete and with different characteristics when compared to other domains. The experiment aimed to investigate how the approach affects the response team's performance during the identification and diagnosis of unforeseen situations at runtime. Initial results indicate the feasibility of the proposal to deal with unforeseen situations while handling irregular phenomena in complex environments.

1.7 Thesis structure

The thesis is organized as follows: Chapter 2 discusses the different phenomena that may occur in complex environments. It also characterizes the unforeseen situations, common in these environments, and details the difficulties faced to diagnose and handle them.

Chapter 3 proposes the use of knowledge about the event for diagnosing and handling the identified unforeseen situations. It also details strategies for the identification and use of the existing knowledge to solve new problems. In addition, it presents and discusses papers whose research focus has similarity to handling unforeseen situations in complex environments.

Chapter 4 describes the proposed approach for on-the-fly adaptation of plans when unforeseen situations are identified during the phenomena handling in complex environments.

Chapter 5 specifies the computational tool to support the proposed approach.

Chapter 6 details the experiment developed for evaluating the proposed approach. It presents the experiment plan, states the research questions, defines the mechanisms used for the data evaluation, details the emergency management domain and discusses the obtained results.

Finally, Chapter 7 discusses the conclusions, contributions, limitations and suggestions for future research topics and research extensions.

2 Phenomena management in complex environments

This chapter introduces the different phenomena that occur in complex environments, focusing on irregular phenomena. It also characterizes unforeseen situations, common in these phenomena, and details the difficulties faced to diagnose and handle these situations.

2.1 From organization to chaos

Everyday people and organizations must handle different phenomena to achieve their goals. Examples of phenomena usually faced are buying products, going on trips, products manufacture, emergencies, medical care, lawsuits, epidemics, economic movements etc.

In regular phenomena, people and organizations can identify well-defined premises, variables and phases to achieve the desired goals and outcomes. In addition, although these phenomena do not occur exactly in the same way, there is a similarity between their instances. This allows identifying a specific and detailed pattern that enables an advance planning and repeated execution each time that such phenomena are identified. Moreover, as the possibilities of evolution can be listed in advance, it is possible to plan alternative actions to be followed during execution. Furthermore, knowing these phenomena details allows the analysis and measure of their operation and impact, which provides inputs for optimizing the phenomena handling (HAMACHER; RAMDAS, 2011; SWENSON, 2010; WESTRUM, 2006).

During products purchase, for instance, at online stores, customers navigate through different sections and add the desired items in their shopping list. These customers must be registered and pay using one of the payment methods provided by the store to complete their purchase. When the purchase is completed, customers can track the order status, from the payment approval to the product delivery. Online stores predict and provide mechanisms to deal with different possibilities that may be faced during products purchase, as redirecting customers to a “sign up” area if they are not registered in the store yet, inactivation of products that are not in stock, messages in case of problems in payment etc.

When going on trips, passengers can use the online service or go to the airline counter to confirm that they will travel on a specific flight. During the check-in, passengers show the necessary documents (identification, ticket number, etc.), define their seat in the airplane and, if necessary, dispatch their luggage. In case of problems, such as overbooking, flight delays, damaged or lost luggage etc., the airline has a set of pre-defined procedures for their solution.

In hiring service providers, for instance through bidding, applicants must meet the established requirements and follow the procedures specified by the law 8666/93 (BRAZIL, 1993). After the envelopes' delivery and opening, the candidate with the lowest cost bid is declared a winner and can provide the resources or requested services.

During products manufacture and distribution, factories purchase or produce internally the required components. The assembly of the final product follows a predetermined order to achieve the best efficiency during this process. The distribution is also defined to reduce costs. Alternative solutions to the problems faced during the products manufacture and/or distribution can be pre-listed as all required steps are known.

All the phenomena cited above enable an advance planning, which can easily be presented through a plan. When facing a specific phenomenon, people can follow the guidelines detailed in this plan (walkthrough) during phenomenon handling.

However, it is not always possible to handle regular phenomena, which require a systematic treatment. In a complex, dynamic and unpredictable world, people and organizations must be prepared to deal with phenomena ranging from total organization and control, where it is easier to identify the details of what may happen, to chaos and decontrol, where a definition of what will occur is not clear (COURTNEY, 2001; KEMSLEY, 2011) (Figure 2-1). As we move toward the latter extreme, planning and handling activities become more difficult and non-trivial (SWENSON, 2010; WESTRUM, 2006).

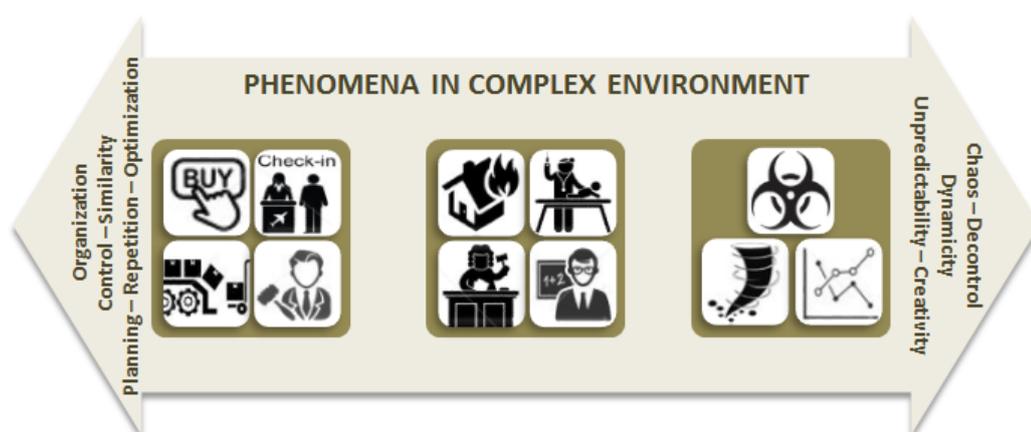


Figure 2-1: Phenomena identified in complex environments

Irregular phenomena do not allow an easier identification of all possible events that may occur and detailing the situations assumed during phenomena in advance. As we move away from the extreme of organization and control, it is found irregular phenomena that

count on a set of premises, variables and phases to achieve the desired goals and outcomes. However, the level of organization and control is not the same of the regular phenomena mentioned above. It is faced a greater level of dynamism, unpredictability and uncertainty that may lead to the identification of new events only at runtime and destabilize parts of the prior developed plan. Thus, planning cannot be entirely detailed since the variety of options and their combinations may generate several situations, which are difficult to be detailed in advance. Therefore, creativity and improvisation are necessary to identify alternative solutions when the prior planning become inadequate (HAMACHER; HOFSTEDE; POWER, 2002; RAMDAS, 2011; SWENSON, 2010; WESTRUM, 2006).

Phenomena with these characteristics may be identified in different domains. The first domain is the emergency management. Its main goal is to establish policies and actions to reduce the vulnerability of a population or the negative impact and consequences of adverse events (HADDOW et al., 2011; KHAN et al., 2008; VUSSC, 2008). The planned actions to deal with emergencies must be followed by teams during the response phase. However, according to the emergency evolution, teams may need to change what was planned. It is necessary because (a) planning cannot totally predict the wide range of possible faced situations (DIIRR and BORGES, 2013; LEY et al, 2013) and (b) the actions described for handling the identified situations may be general, to not compromise and specialize the response, or very specific, making the plan become inadequate to major variations.

Another domain is the medical care. When a patient is admitted to a hospital for medical care, physicians follow a set of procedures to treat the patient. These procedures are listed based on the guidelines established by the hospital, the knowledge obtained during medical training and the experience that the physician had when treating other patients with similar symptoms. However, the way that the treatment will be applied varies according to the patient being treated. Issues as the faced disease, which is only determined by analyzing the symptoms described by the patient and conducting complementary exams, and the patient characteristics, as family history, pre-existing diseases, allergies etc., specify the adopted treatment. In addition, another factor that leads to the need for treatment change is the patient's response to the procedures adopted by the physician. According to this response, all or part of the adopted treatment should be changed.

A third domain is the lawsuits. Despite all legal actions are guided by well-defined standard procedures, such as laws, regulations, norms etc., each lawsuit is a case that has

specific characteristics. It may evolve in a very different way when compared to other lawsuits with similar characteristics because of the material obtained by the people involved, the argument used by both defense and prosecution, agreements made etc. Thus, the way of the lawsuit is handled will only be clear after the judge's decision.

The last domain is education. At a high level, it is possible to describe that teachers perform three steps during a course: class preparation, teaching and learning assessment. However, detailing these steps varies and is influenced by those involved in each course, i.e., teacher and students. Teachers are free to choose, among the different methods and techniques that can be applied in each of these steps, a method/technique suitable to their preference and to the students in the course. Teachers may assess students' feedback to each method or technique applied and change it when there is such a need. Thus, there is no guarantee that a successful dynamic in a course, which has a specific configuration of students, will lead to the same results when the course is offered again.

When reaching the extreme of chaos and lack of control, it is usual that a prior model for handling the irregular phenomena cannot be developed. The irregular phenomena found in this extreme constantly face events that are new, unknown, unexpected and different from the usual. It inhibits any planning in advance and makes difficult to predict all possible situations that may happen. Thus, it is necessary more creativity and improvisation to identify alternative solutions for handling the observed situation (HAMACHER; HOFSTEDE; POWER, 2002). Epidemiological phenomena, climatic phenomena and economic movements are examples of phenomena with these characteristics.

Considering the variety of phenomena encountered in complex environments, as closer as a phenomenon is from the extreme that it is possible to ensure certain organization and control, its treatment is easier. As we move away from this extreme, new difficulties are imposed. It is necessary to deal with irregular phenomena, which have subjective and often tacit definitions; possess dynamic execution; require creativity in execution and decision-making; face unexpected restrictions; generate unpredictable decisions; and evolve based on experience gained by the teams involved (DE MAN, 2009; FRANKE et al., 2010; LAKSHMANAN et al., 2012; RICHTER-VON HAGEN et al., 2005; SWENSON, 2010; WESTRUM, 2006; WHITE, 2009). Thus, the faced phenomena are very singular, and planning and handling activities become more complicated.

2.2 Managing irregular phenomena

Although usual, it is not a trivial task to plan and execute actions for handling irregular phenomena in complex environments (Figure 2-2).

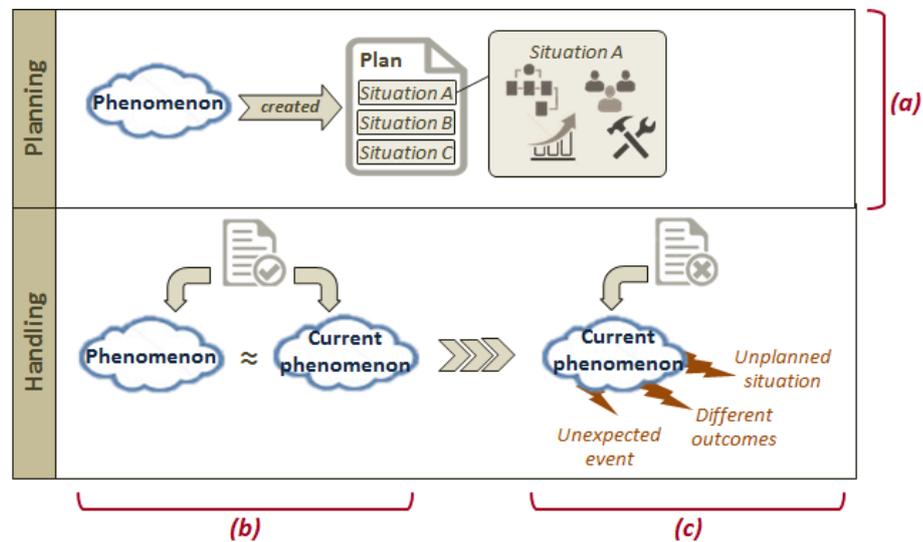


Figure 2-2: Planning vs. Handling of irregular phenomena in complex environments

During planning (Figure 2-2a), the planning team tries to devise an artifact (plan) that details the different events and situations that may be faced during the irregular phenomena handling. To achieve the desired goals and outcomes, the planning team use the existing knowledge on premises, variables and phases to design norms and procedures that, if followed, should make the irregular phenomenon evolve to an expected situation. The planning team also identifies the required response team, equipment and information for handling the expected situations (HADDOW et al., 2011; PENADÉS et al., 2011).

Ideally, when a similar irregular phenomenon is identified, it is possible to retrieve the prior developed plan and use it to handle the ongoing phenomenon (Figure 2-2b). According to the ongoing situation characteristics, a set of procedures described in the plan will be defined as suitable to be adopted during the phenomenon handling. These procedures are performed sequentially until the phenomenon goal is reached. Thus, it is possible to say that executing a plan resembles a business process execution (CANÓS-CERDÁ et al., 2014; CHANDRA e KRISHNA, 2011; SELL e BRAUN, 2009).

However, the use of a prior developed plan is not always straightforward (Figure 2-2c) (ALEXANDROU et al., 2009; BARTHE-DELANOË et al., 2014; BÖHRINGER, 2010; GIL, 2015; LAKSHMANAN et al., 2012; MENDONÇA e WALLACE, 2007; SAWYER et al., 2010; SYKES et al.,

2013). The lack of knowledge about the irregular phenomenon details makes difficult to generate a plan that specifies well-defined procedures to address all contingencies that may arise during its evolution. It is common that the planning team only identifies a subset of all possible events that may happen because this team must handle a wide variety of options and their combinations. This simplification makes difficult to detail all possible situations in advance. In addition, the planning team may decide to leave out a specific situation in the developed plan, even if its occurrence is possible, either because it is necessary to simplify the plan or because the occurrence of such situation may be rare. Moreover, the planning team may provide an inadequate treatment for a specific event, either because the situation caused by its occurrence has never been experienced or because of the unpredictability and uncertainty associated with it. Besides that, the plan may also be described at a higher level of abstraction to not specialize how the response team will act.

Therefore, the lack of a well-detailed plan may lead to the discovery of new variables and unexpected events that need to be handled only at enactment time. In addition, the decisions and actions performed also affect the observed situation, leading the response team towards facing states that may not correspond to the states defined during planning. Moreover, even for known situations, different outcomes may be identified when the planned actions are applied in this partially known environment, either because these actions were poorly executed or because they could not reach the expected effects.

2.3 Unforeseen situations

More complex, dynamic and unpredictable environments commonly face events that affect the prior developed plan. These events may lead to an unforeseen situation, which, in its turn, may lead to a disruption (Figure 2-3). The disruption makes more difficult to the prior developed plan proceed as expected, and, as result, it may become no longer applicable to handle the ongoing irregular phenomenon.



Figure 2-3: Unforeseen situation

Unforeseen situations may arise due to different causes. The first cause concerns the lack of completeness of the prior developed plan. As discussed above, the lack of knowledge about the irregular phenomenon during planning may lead to a plan that does not detail all possible situations and events that may be faced, and/or describe handling in an inappropriate level of details. For instance, consider the phenomenon shown in Figure 2-4. This phenomenon may face three different situations: “Situation A”, “Situation B” and “Situation C”. For “Situation A”, the procedure detailed in the plan is adequate and can be followed during this situation handling. For “Situation B”, the plan details a procedure to be followed, but it lacks some details about the required information and equipment. It is necessary to analyze and infer these details so the procedure can be applied during this situation handling. For “Situation C”, no procedure has been detailed during planning. Thus, it is necessary to devise a procedure for handling this situation at runtime.

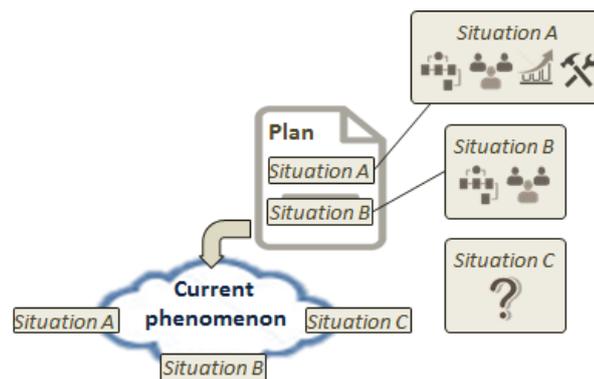


Figure 2-4: Unforeseen situation caused by inappropriate plan detailing

An unforeseen situation may also arise by the plan application in the ongoing irregular phenomenon. During handling, the plan application may make the response team face a situation evolution and achieve results that do not match those defined during planning. It happens because the decisions and actions performed during handling also affect the observed situation. In addition, the lack of prior experience in the irregular phenomenon and the unpredictability and uncertainty associated with the environment may lead to developing procedures that only show themselves inappropriate at runtime. For instance, consider the hypothetical irregular phenomenon handling shown in Figure 2-5. The prior developed plan application begins at “t0”. At “t1”, the decisions and actions taken by the response team make the observed situation evolution match its expected evolution. It allows the use of the existing plan. However, at “t2”, a decision makes the situation evolve to a state that was not expected.

Thus, it is not possible to apply the procedures detailed in the plan at “t3” because the observed situation evolution is much different from its expected evolution.

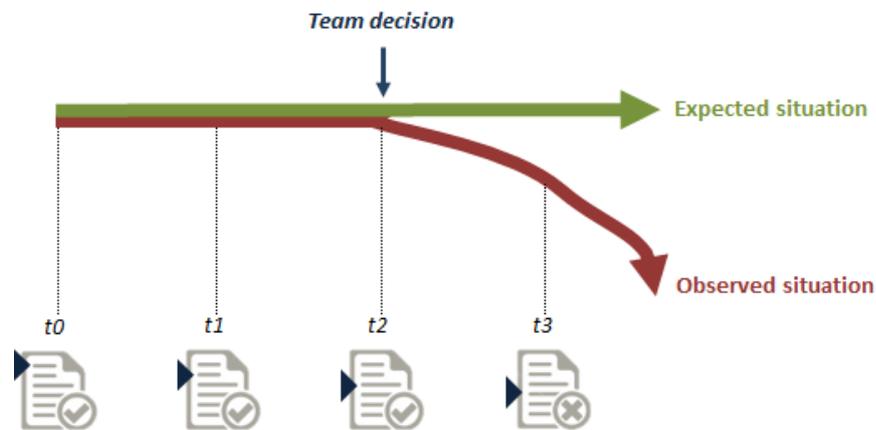


Figure 2-5: Unforeseen situation caused by decisions and actions performed during handling

Besides facing situations and results that do not match the situation and result defined during planning, the plan application may also lead to unforeseen situations related to procedures concurrency. Handling phenomena in complex environments involve acting in response to different events, which often occurs simultaneously. It may lead to the unavailability of prerequisites because they are being used to handle another situation(s). For instance, consider the procedures adopted for the two situations shown in Figure 2-6. At “t2”, one response team allocates the necessary resources for performing the second action for handling the “Situation A”, which was originated from the first event, while another response team still performs the first action planned for “Situation B”, which was originated from the second event. When the response team responsible for “Situation B” tries to allocate the necessary resources for performing the second action for handling this situation at “t3”, it discovers that one resource is unavailable. If (a) it is not possible to provide the necessary resource, for instance, there is no extra resource, or (b) the resource provision will need more time than the available, it is not possible to continue handling the “Situation B”.

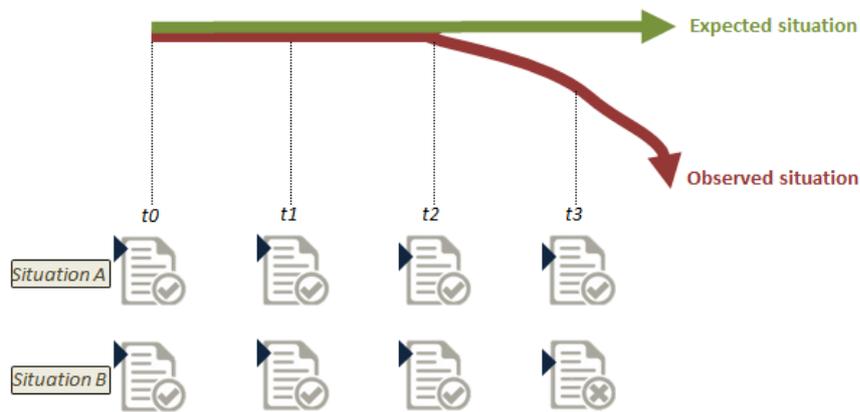


Figure 2-6: Unforeseen situation caused by unavailability of prerequisites

Another cause for unforeseen situations concerns the occurrence of unexpected events. They may make the response team face situations that do not match the situations defined during planning. For instance, consider the hypothetical irregular phenomenon handling shown in Figure 2-7. The prior developed plan application begins at “t0”. At “t1” and “t2”, the decisions and actions taken by the response team make the observed situation evolution match its expected evolution. It allows the use of the existing plan. However, the observed situation evolution does not correspond to the expected evolution at “t3”. It happens because an event has changed one of the necessary conditions between “t2” and “t3”. As this event was not predicted in the plan, it is not possible to continue the irregular phenomenon handling.

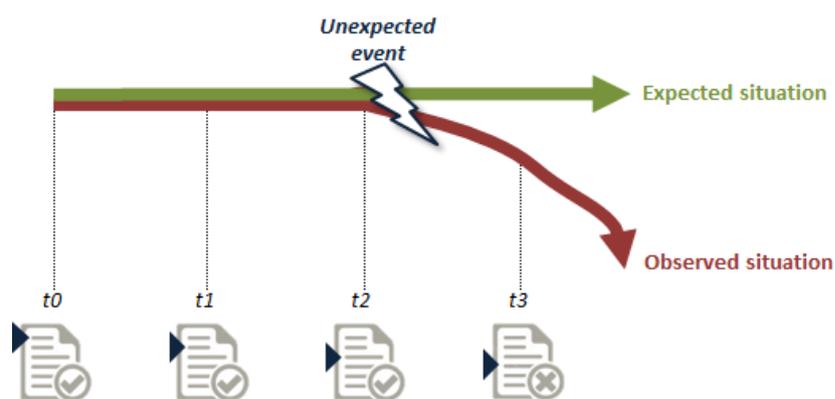


Figure 2-7: Unforeseen situation caused by unexpected events

When an unforeseen situation occurs, the response team should observe the operation conditions, identify the new set of goals to be achieved, use creativity and improvisation to identify alternative treatments and make decisions at runtime. Thus, the identified unforeseen situation can be solved and the ongoing phenomenon handled

(BÖHRINGER, 2010; LAKSHMANAN et al., 2012; LEY et al., 2012; LEY et al., 2014; MENDONÇA and WALLACE, 2007). All gathered information provides feedback about the phenomenon handling and may be used as input for a plan evaluation.

However, handling unforeseen situations that occur in complex environments at runtime is not a trivial task. Identifying unforeseen situations occurrence is not always obvious. In addition, diagnosing the impacts they have in the response procedures and demanding a possible adaptation can prove a difficult task. Moreover, plan adaptation at runtime itself must be systematized to handle unforeseen situations properly and make the plan suitable to what is happening.

Thus, the problem addressed by this research is

the difficulty in diagnosing unforeseen situations and adjusting prior developed plans at runtime

2.4 Problem confirmation: Labors and Emergency response

Interacting with groups who constantly deal with unforeseen situations and plan adaptation at runtime is necessary to a better understand of how it occurs. Thus, interviews with professionals were carried out to confirm the problem existence and identify usual methods used to diagnose and handle these unforeseen situations.

The first interaction was with physicians (obstetricians and anesthesiologists) who are used to handle labor in emergency rooms. Emergency rooms provide immediate medical and surgical care to patients arriving at the hospital without prior appointment. When working in these departments, physicians must treat a broad spectrum of pregnant women, who may be facing cases of normal labor, preterm labor, abortion, preeclampsia, uterine rupture, prolapsed umbilical cord, dead fetus etc. Patients' characteristics also influence the recommended treatment application. For instance, a history of poor blood clotting may require a blood transfusion during labor. This diversity of characteristics generates many alternatives to handle. In addition, decisions may be made with incomplete information, since the patient may not be able to provide (e.g. unconsciousness) or may not have (e.g. lack of prenatal care) the necessary information for adequate care. More than that, there is pressure to make quick and critical decisions to treat life-threatening cases faced. Furthermore, any change in patient's condition requires selected treatment reevaluation (BOYLE, 2011;

DEERING, 2009; ESKANDARI et al, 2011; LEZZAR et al, 2012; MOON and KIM, 2013; PEREIRA et al, 2014; PUNDT, 2011; VRBASKI and PETRIU, 2013). Besides medical procedures detail a broad spectrum of labor possibilities, they often need to be adjusted to handle specific cases faced in emergency rooms because of their variety and unpredictability (BOYLE, 2011; DEERING, 2009; PUNDT, 2011; SELMAN and JOHNSTON, 2013). Thus, physicians must capture and analyze the available information about the patient (historical and current conditions), make claims about the application and effects of all procedures already adopted in this specific case, identify alternative treatments from literature and prior experience in similar cases, and make decisions at runtime to adjust recommended procedures to the specific case faced.

The second interaction was with Civil Defense agents who work in the control team, managing the information coming from different sources and controlling people working in the affected area (operation teams, governmental agencies, non-governmental organizations, the private sector and society). These agents must handle a wide variety of natural threats, such as flooding, landslides, windstorms etc., which can occur at any time and evolve in unforeseen ways. Besides adopting procedures that provide initial treatment for an emergency, the dynamic and complex characteristic of emergencies may lead several alternatives to handle that were not foreseen before. In addition, Civil Defense agents usually make critical decisions in the spur of the moment, since the faced emergencies are life threatening and need immediate attention. Moreover, these decisions are made with incomplete or partial information, bearing impacts on emergency response. Furthermore, any change in emergency evolution requires a reevaluation of the selected treatment. Thus, Civil Defense agents must capture and analyze the available information about the emergency evolution, make claims about the effects of all actions already applied and decisions already made, identify alternative treatments from prior emergency responses, and make decisions at runtime to adjust the existing procedures to the emergency faced.

2.5 Final comments

This chapter has detailed the different phenomena that may occur in complex environments. By identifying phenomena ranging from total organization and control to the chaos and decontrol, it was discussed that, as we move away from the extreme of organization and control, new difficulties are imposed and the planning and handling activities become more complicated. The dynamism and unpredictability of the environment hinder a well-

detailed planning since it is not possible to know all the irregular phenomena details in advance or to list all events that may happen and possible situations arising from them. Furthermore, different unforeseen situations may occur during the irregular phenomena handling, which makes the plan become inappropriate to be followed. It requires greater creativity and improvisation to identify alternative solutions and make decisions at runtime (Figure 2-8).

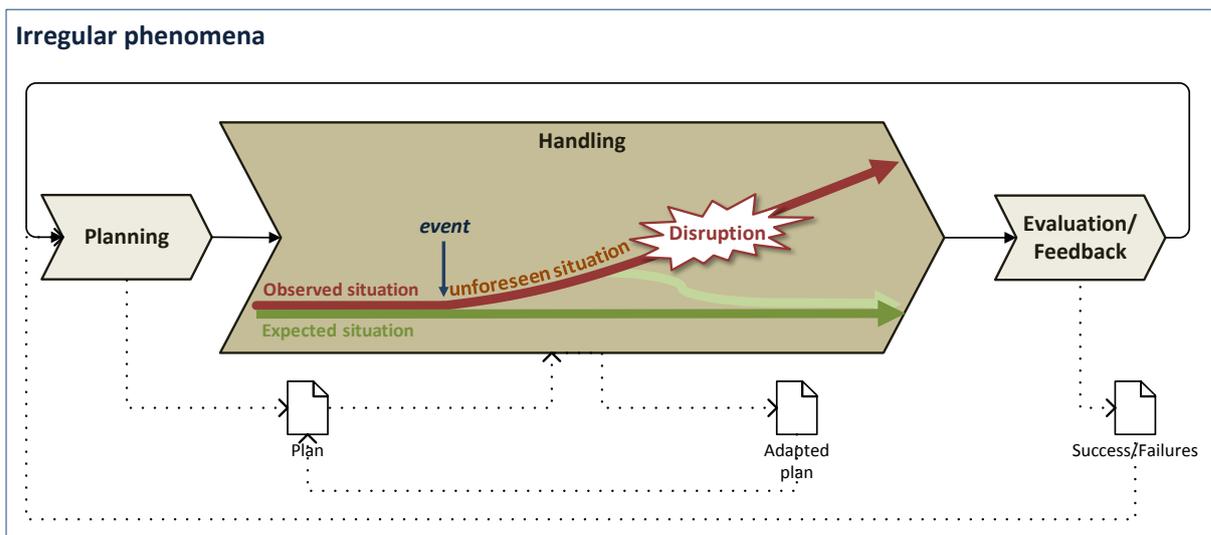


Figure 2-8: Problem inside thesis scope

The difficulty in applying prior developed plans while handling irregular phenomena suggests the need to provide a wider support to decision-making when dealing with unforeseen situations. It is necessary to make available mechanisms that allow, at runtime, identifying and diagnosing unforeseen situations and, if necessary, adjusting the plan to address the problems identified. Thus, the identified unforeseen situation can be solved and the ongoing phenomenon handled.

3 Knowledge arising from phenomenon evolution as input for managing unforeseen situations

This chapter presents the benefits obtained from the analysis of knowledge arising from the phenomenon evolution for the unforeseen situations diagnosis and handling. It also details strategies for identification and use of the available knowledge to solve new problems at runtime. Finally, it presents proposals for managing unforeseen situations.

3.1 Diagnosis and solution of problems from knowledge about the phenomenon

As explained in the previous chapter, the prior developed plans will not always be suitable for handling irregular phenomena. The dynamism and unpredictability of the environment in which irregular phenomena occur hinder a well-detailed planning, making the real situation that needs to be addressed becomes clear only during the phenomena handling. The possible events and faced situation are presented at this point, which allows concluding the plan development. It is also possible to identify if some unforeseen situation has occurred and assess if the existing plan is still suitable for handling the phenomenon observed situation. If not, the response team must decide and perform adaptations at runtime to solve the unforeseen situations, make the plan becomes proper to what is happening and continue the irregular phenomenon handling.

The difficulty in applying prior developed plans while handling irregular phenomena suggests the need to provide a wider support to decision-making when dealing with unforeseen situations. The main goal of this thesis is to assist the response team in diagnosing unforeseen situations and making adjustments while the selected plan is being applied. For this, it is proposed the use of the knowledge arising from the phenomenon evolution. This knowledge can be identified from prior or current knowledge about the phenomenon (DINIZ, 2005). It is claimed that the analysis of these knowledge allows a better understanding of the ongoing phenomenon and devising solutions that may inspire or be applied to the identified unforeseen situation.

Using the knowledge arising from the phenomenon evolution for diagnosing and handling new situations is quite common. For instance, it is identified in strategy games like

chess. The goal of chess is cornering the king. For this, it is necessary to move the pieces on the board according to a strategy defined in advance. This strategy considers the position of both player's and his/her opponent's pieces, the value of each piece, necessary sacrifices, the moment to move the piece forward or backward, the board occupation etc. However, during the game, the player may face situations that confront his strategy. For instance, the opponent made a move that was not predicted in the strategy adopted by the player. Thus, the player must analyze the board configuration after his/her opponent's move to identify which piece should be moved to win the game. For this, the player may use his/her experience in other games or the strategies known by chess players to respond the opponent's move. After moving the piece, the player also evaluates his/her opponent's reaction to decide if the new strategy is the most appropriate for the game. If not, the player can use his/her experience in other games or other known strategy to change the strategy adopted in this game.

Another example is the identification of treatments for diseases. When a patient describes his/her symptoms, the physician tries to identify the disease that is causing them. The disease can be identified through the analysis of the symptoms and/or results of the performed tests. When the disease is confirmed, the physician recommends a treatment to be applied by using his/her medical training and experience when treating other patients with similar symptoms. Sometimes, physicians identify that the patient's response to the treatment does not follow the usual pattern of the disease. In these cases, he/she may consult the medical literature to identify reports describing similar situations. In addition, physicians may also apply indirect treatments, i.e. treatments that do not cure the patient's symptoms but lead the patient's condition to a state where it is possible to identify a proper treatment.

These examples show that the use of the knowledge arising from the phenomenon evolution for diagnosing and handling new events and situations follows a process similar to the decision-making process (Figure 3-1) (SIMON, 1977). First, it is necessary to identify the need for a decision, i.e. to understand what is different in the environment that may be considered a problem that needs to be addressed (intelligence phase). After that, it is possible to analyze the identified problems, thus providing a diagnosis for them and generating alternatives to be applied (design phase). Finally, the most appropriate solution for the problem is selected from the possible alternatives (choice phase). Each phase for decision-making is also considered a decision-making process, which may generate new problems that have phases of intelligence, design and choice.

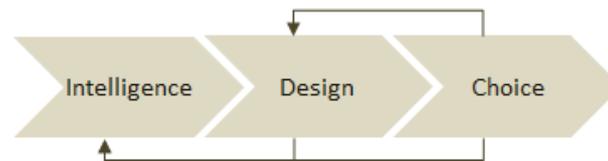


Figure 3-1: Decision-making process

3.2 Strategies for solving problems using the existing knowledge

Different strategies may be adopted for using the knowledge arising from the phenomenon evolution for diagnosing and handling new events and situations. These strategies range from organization, storage and retrieval of knowledge through documents; may adopt techniques for automatic comparison and modification of the existing knowledge before using in the current phenomenon; and may involve creativity to define how the existing knowledge can support the observed situation. The following subsections detail some of these strategies.

3.2.1 Lessons learned

The documentation of lessons learned helps to discover the project strengths and weaknesses. It allows members and/or partners of the project team to discuss the project successes, the unexpected outcomes or results that did not meet the initial expectations, possible recommendations for future projects, what could have been done differently, the causes of problems that have occurred and ways to prevent these problems from occurring again (BUTTLER and LUKOSCH, 2012; BUTTLER and LUKOSCH, 2013; DUFFIELD and WHITTY, 2012; WHITE and COHAN, 2010).

There are different mechanisms or processes used to collect, verify and disseminate lessons learned. In general, the process for documenting lessons learned can be defined through the following steps (Figure 3-2) (BUTTLER and LUKOSCH, 2012; BUTTLER and LUKOSCH, 2013; WHITE and COHAN, 2010):

- **Project definition:** The project team identifies the need for documenting the lessons learned, establishes the procedure for documentation and defines the members that will provide this knowledge;
- **Collection:** The project team captures information through structured and/or not structured processes, as critics, documentation and meetings, to identify both positive experiences, which has reached the organization goals, and negative experiences, which has generated undesirable outcomes. It may occur integrated to the project,

when lessons learned are identified regularly and consistently through project reports; or post-facto, when the project requires an analysis after its end;

- **Verification and synthesis:** It is used to verify the accuracy, correctness, understanding and applicability of the identified lessons, determining if a specific lesson is relevant or not for other projects, exclusive to a single department or specific project, or may be applied to the whole organization;
- **Storage:** The lessons learned are stored into a knowledge management system or database for future dissemination. They should contain information about the problem, the adopted solution, the expected and obtained results, the factors that may have influenced these results, the recommendations of what should or should not be done, the challenges faced etc.;
- **Dissemination:** Past lessons or best practices are disseminated. It may be necessary to review processes and conduct training.



Figure 3-2: Process for documenting lessons learned

When necessary, teams involved in the project may use the lessons learned to solve problems in the project they are working on. They may use these lessons to change standards, guidelines, norms and processes; create awareness about an issue described in a lesson learned; monitor and prevent problems in projects; or proactively prevent problems when implementing an approach described in a lesson learned (BUTTLER and LUKOSCH, 2013).

3.2.2 Case-Based Reasoning (CBR)

Research on Case-Based Reasoning (CBR) argues that the analysis of past cases allows identifying solutions that can be adapted and applied to a new problem faced through a cycle comprising four steps (Figure 3-3) (AAMODT and PLAZA, 1994; KOLODNER, 1993; LÓPEZ, 2013; DE MÁNTARAS et al., 2005; RIESBECK and SCHANK, 1989):



Figure 3-3: CBR cycle

- **Retrieve:** When a new problem is faced, a set of potential similar cases is retrieved from a library. The cases and problem are compared to reject the cases that differ greatly from the problem faced and determine the case that is the most similar to the problem faced. The similarity of cases depends on how well each comparison dimensions have matched and the importance of each comparison dimension;
- **Reuse:** The solutions described in the selected case are applied as a solution to the problem. There is no need to make any modification on them. I.e., what was done in the case is the correct thing to do to the current problem;
- **Revise:** When the recovered case differs in some aspects of the current problem, it is necessary to list what is different between the selected case and the problem faced, and change the solution described in this case to address such differences. Sometimes, the selected case requires only simple changes. Other times, this case differs greatly from the problem and not all necessary adjustments can be performed automatically. When it happens, human experts must analyze the case;
- **Retain:** Experience in solving the problem faced is stored as a new case in the library, so it can be a reference in future occasions.

3.2.3 Improvisation

Improvisation derives from the Latin word *“improviso”* (*“im”*, denial of something, and *“proviso”*, stipulating beforehand, predict). It deals with the unforeseen and is described as a continuous and sequential process, which runs with little or no preparation or prior planning,

and involves the interpretation, articulation and design of something while it is being performed (LEWIS and LOVATT, 2013; LEY et al, 2012; OXFORD; WEICK, 1998). Improvisation becomes necessary when events considered important or impactful are faced and require an immediate response. Although relevant, such events could not be anticipated and, because of that, there are no plans for handling them (LEY et al, 2012; LEY et al., 2014; LONG and YU, 2009).

During improvisation, the resources available at that time are retrieved and recombined to generate new outcomes and solutions that meet the situation arising from a specific event (LEY et al, 2012; LONG and YU, 2009; MENDONÇA and WALLACE, 2007; PRESSING, 1988; TAN and HALLO, 2008; WEICK, 1998). Improvisers need a divergent thinking, i.e. coming up with as many possible solutions for a specific task or a given problem as possible, to continuously think of something new in a flexible manner (CARR and BORKOWSKI, 1987 apud: LEWIS and LOVATT, 2013).

As improvisation occurs during the execution of something, the solution design and execution seem to occur simultaneously and in the spur of the moment (LEWIS and LOVATT, 2013; LEY et al, 2012; OLSSON and BACKSTROM, 2012; WEICK, 1998). However, despite the improvisation seems a totally ad-hoc process, with no mechanism to support it, it is not true. *"You cannot improvise on anything; it is necessary to improvise on something"* (KERNFELD 1995 apud: WEICK, 1998). When improvising, people activate referents/schemas to provide a basic template for themselves to solve the problem faced. New ideas can then be integrated into these referents/schemas, which allows devising different solutions for the problem faced. Thus, different improvisations may be generated from this referent/schema (LEWIS and LOVATT, 2013; MENDONÇA and WALLACE, 2007; PRESSING, 1988).

Improvisation can be performed at different levels and treated as an individual or a group phenomenon (MOORMAN and MINER, 1998). Improvisation levels are related to the depth of change used in the improvised object. For instance, jazz musicians may use improvisation levels ranging from "interpretation" or minimum adjustments of an existing melody (through the "embellishment" and "variation") to the radical change of the original melody ("improvisation") (BERLINER, 1994 apud: WEICK, 1998). The "interpretation" occurs when people take small liberties with the melody as when choosing new accents or dynamic as they perform what is written. The "embellishment" involves a greater use of imagination, anticipating or delaying whole sentences of the original melody. The melody is changed but

still recognizable. The “variation” occurs when musicians insert notes that are not in the original melody, but their relationship with the original melody is clear. “Improvisation” transforms the melody in something that has little or no resemblance to the original melody. When analyzing the different improvisation levels, it is observed that “interpretation” and minor adjustments depend on the models from which they have started, while the extreme improvisation depends on past experience and memory (DYBA, 2000).

The classification of improvisation as an individual or a group phenomenon concerns the people involved and the resources used during this process. When only one person improvises, this individual will use his/her own knowledge and experiences lived on other occasions, besides the available physical resources, while improvising. When a group of people improvises, they should combine the knowledge, skills and experiences lived by each of these individuals to generate a new result.

Thus, improving improvisation requires improving the group or individual memory. It is achieved by providing a wider range of resources for improvisation, which allows a greater possibility of creating new relationships between the resources available at the time of improvisation and between these resources and improvisers’ experiences in other occasions (LONG and YU, 2009; MENDONÇA and WALLACE, 2002; WEICK, 1998). Moreover, it is necessary that individuals or group understand what is being developed and why improvisation efforts are being spent (OLSSON and BÄCKSTRÖM, 2012).

3.3 Proposals for managing unforeseen situations by using the existing knowledge about the phenomenon

Literature presents different proposals on the use of existing knowledge about the phenomenon to handle unforeseen situations at runtime. Regarding the identification and diagnosis of unforeseen situations, studies propose the use of the emerging data to compare what was planned and what is being observed during handling. It allows assessing if the existing plan is still valid and relevant to handle the current observed situation. Comes et al. (2012) work with new or updated information received by the emergency response teams. From the information that details the current emergency evolution, managers have inputs for updating the previously established scenarios. They use this information to decide if the scenario handling is still valid and relevant for its purposes or if the new information presents sufficiently important facts to ensure the scenario updating. Martens et al. (2012) argue that

case management systems allow some level of visibility and control of processes with unstructured segments of activities and reactions to exceptional situations. The authors propose a system that analyzes the execution traces and cases data to improve efficiency, ensure compliance and provide guidance for people involved. It allows estimating the case health, i.e. an estimate of how well the case is progressing based on the analysis of its current status. If the case evolution is not appropriate, actions to adjust the case are necessary. Alexandrou et al. (2009) and Moon and Kim (2013) argue that the standard procedure for treating the same disease varies according to the patient's characteristics and the situation faced. The authors provide mechanisms to capture information about the current situation of the patient under treatment. This information serves as input to assess if the standard medical procedure is suitable to be applied and, if not, which changes are needed. Thus, healthcare professionals can provide personalized treatment to the patient. Barthe-Delanoë et al. (2014) gather data coming from both the field and the monitoring of workflow to deduce automatically additional information about the current conditions of the phenomenon handling. The deduced information helps to identify mismatches in the existing plan and supports the decision-making process for adjusting this plan.

Regarding the adaptation of plans at runtime, some works suggest the use of similar previous phenomena for identifying solutions to be applied. Li and Ma (2009) propose the concept of flexible blocks to describe uncertain factors before running processes. This flexible block runs in an ad-hoc way and, after some repetitions, an internal process structure is obtained by mining the process operation history. After that, the application scenarios are combined and the process model of the flexible block are organized and stored in bases, enabling its use on future occasions. Chakaborty et al. (2010) propose a system to identify similar cases to work in domains where there is not enough understanding that enables the prior development of an in-depth handling model, as in firefighting. Managers may retrieve a set of cases that have similar characteristics to the current conditions of a fire. These cases are adapted to devise a solution for handling the current fire. Minor et al. (2011) propose a system for creating and adapting workflows by reusing automatic changes. When a request for workflow change occurs, managers retrieve experience on previous adaptations from a case library. These cases are assessed, and the most appropriate alternative is applied as a solution to the problem identified in the current process. The system proposed by Martens et al. (2012) also provides mechanisms for adaptation at runtime. The system allows identifying

other cases that have similar characteristics in the current case. Thus, managers can learn what has been done and propose solutions from the actions taken in each case.

Other studies provide recommendations on the next action that should be performed to achieve the expected goal from the analysis of what is happening at any given time of execution. Schonenberg et al. (2008) provide recommendations to the end users of a process, allowing them to deal with a partial case, i.e. cases that have started but have not yet been completed. These recommendations are generated based on past performance of similar processes and contain information on how to achieve a certain goal (optimize profit, cost, time etc.). As different users aim to achieve different goals, the recommendations offered are different for each of them. Dorn et al. (2010) propose an approach for ad-hoc processes treatment oriented to people. Information describing these processes execution is analyzed. This understanding enables the recommendation on the next action to match the current situation of the process execution. Comfort et al. (2013) propose a model that uses existing information about the evolution to assess and offer options to handle urgent events. From a set of options, the model calculates which one may achieve the most effective result to protect the community. The response teams should adopt the most appropriate option.

Understanding the context and the emerging data from execution are also used to configure or instantiate a prior developed plan. Studies on processes adaptation at runtime (BUCCHIARONE et al., 2011; HERMOSILLO et al., 2010; NUNES et al., 2011; SANTOS et al., 2011) propose to perform modifications when any deviation is identified during the process model instantiation to a specific context. The object of adaptation is a well-defined process, repeatable, little complex and with little possibility of change. It makes modification be more easily designed and controlled. The goal is to modify the existing models so that their instances reflect and are suited to the faced context. Rychkova and Nurcan (2011) propose an approach for adaptation and control of dynamic, unstructured and knowledge-intensive processes. After the planning phase, where is defined what can be done to execute the process and what is required for it, the approach follows the customization phase, that focuses on what should be done to execute the process in a specific context and what is available for it. During the last phase (execution), the process is configured at runtime based on the emerging data. Thus, the processes will match the conditions of the context in which they occur. Alexandrou et al. (2009) propose the adaptation of health care procedures at runtime. During these procedures execution, the proposed system uses an ontology, which describes the necessary knowledge

and a set of semantic rules, to analyze the patient's situation and reconfigure the next steps of treatment. Thus, the execution of healthcare procedures for each patient is customized and based on his medical condition and response to the applied treatment. Moon and Kim (2013) propose an integrated architecture that detects the current situation of the patient under treatment using ubiquitous devices. This information assists the healthcare professionals to provide personalized treatment to the patient since the standard medical procedure for the same disease varies according to the patient's characteristics and the faced situation. The proposal from Barthe-Delanoë et al. (2014) for automatic deduction of the observed situation from data provided by field teams and workflow monitoring also allows the plan adaptation. When the need for adaptation is identified, the deduced information allows providing a range of adaptation solutions to support the decision-making process.

Improvisation may also be used to generate solutions to the identified problems. Mendonça and Wallace (2007) propose a cognitive model for improvisation in emergency management. This model helps to obtain a referent from the declarative and procedural knowledge when a contingency that blocks the execution of a planned procedure occurs. This referent is modified, making it consistent with the existing goals and available resources. Ley et al. (2012) claim that improvisation is a helpful resource to be used by crisis management teams, but it may become a challenging task if the magnitude of the emergency leads to the collaboration of different organizations. These organizations need to improvise in an interorganizational level and the IT infrastructure is not always prepared for this. Thus, the authors propose the migration to an IT structure that supports the informal information exchange and generation of opportunities for informal collaboration between the different organizations involved. Dybå (2000) and McGann and Lytinen (2010) detail the benefits obtained from the application of improvisation in software organizations. Improvisation helps to identify alternatives that allow dealing with the inherent unpredictability, dynamics, uncertainty and unknown of the systems development process.

Although these studies describe proposals that could help to manage unforeseen situations in complex environments, this research claims that there is a lack of support in the decision-making process for handling unforeseen situations as a whole. I.e. from identification of unforeseen situations, going through diagnostic of their impact on the existing plans, to perform adjustments to make the plan suitable for handling the phenomenon observed situation. Besides that, facing unforeseen situations requires handling both explicit and tacit

knowledge. Using explicit knowledge allows identifying events that were not predicted and provides inspiration for defining actions to handle the situations arising from them. However, some events and unforeseen situations may not have relations with any past explicit knowledge, being necessary to provide mechanisms for identifying, handling and using tacit knowledge too.

3.4 Final comments

Using the knowledge elements about the phenomenon may bring benefits for the on-the-fly adaptation of plans in unforeseen situations. Current knowledge allows understanding what is actually happening during the irregular phenomenon handling and identifying potential unexpected events and unforeseen situations. Prior knowledge allows identifying successful past phenomena that may be relevant for handling the ongoing phenomenon and possible unforeseen situations. It is also possible to identify the failures on other phenomena, which suggests strategies that should not be followed so the same error does not occur again. Moreover, even if it is not possible to establish a connection between the existing knowledge and the unforeseen situation, this knowledge serves as input to create new connections between the resources available. I.e. new connections between the existing knowledge and/or between this knowledge and prior experiences of involved teams. Thus, a new solution to handle the unforeseen situation can be developed.

Therefore, the hypothesis to be validated in the present research is

the use of the knowledge arising from the phenomenon evolution helps the on-the-fly adaptation of the existing plan when unforeseen situations occur

4 Plan adaptation in unforeseen situations

This chapter details the approach for on-the-fly adaptation of plans when unforeseen situations are identified during irregular phenomena handling. This approach makes use of the available explicit and tacit knowledge about the irregular phenomenon, and supports decision making in complex environments from the identification of unforeseen situations, going through the diagnosis of the impact of such situations in the existing plan, to the plan adaptation for properly handling the irregular phenomenon observed situation.

4.1 Approach for on-the-fly adaptation of plans in unforeseen situations

As highlighted before, the exact application of plans in complex environments is a difficult task. Plans usually become inadequate and adjustments are often demanded. The approach for on-the-fly adaptation of plans in unforeseen situations (DIIRR et al., 2015) provides the response team with information and tools that allow the plan adjustment when the phenomenon observed situation does not correspond to the situation described in the plan. It supports the identification of unforeseen situations, the diagnosis of their impact on the existing plan and the adjustment of plans that become inappropriate for handling the phenomenon observed situation. For this, it is proposed the use of the knowledge arising from the phenomenon evolution, which is identified during the phenomenon handling and/or concerns the prior experience in similar phenomena (Figure 4-1).

During the **plan monitoring**, the response team monitors the selected plan, considering the phenomenon observed situation and a set of pre-established parameters. This analysis allows establishing a compliance degree between what was planned and what is actually happening during the phenomenon handling. Thus, it is possible to assess if the plan can still be applied to the phenomenon observed situation or if is required a more detailed analysis of what is not working anymore.

The **unforeseen situation interpretation** aims to determine if the unforeseen situation that was identified during plan monitoring has produced a disruption in the plan. Disruptions make the plan more difficult to proceed as expected, making it become no longer applicable to handle the phenomenon observed situation. According to a set of criteria, the response team characterizes the unforeseen situation that has occurred and decides if there is a need for adjusting the selected plan.

The response team performs a **plan adaptation** when the identified disruption leads to the non-applicability of the existing plan. According to the required adaptation level, the response team uses all available knowledge to develop and select alternative solutions for handling the disruption faced.

The result of the on-the-fly adaptation, the adapted plan, is applied during handling, thus initiating a new cycle of the approach application.

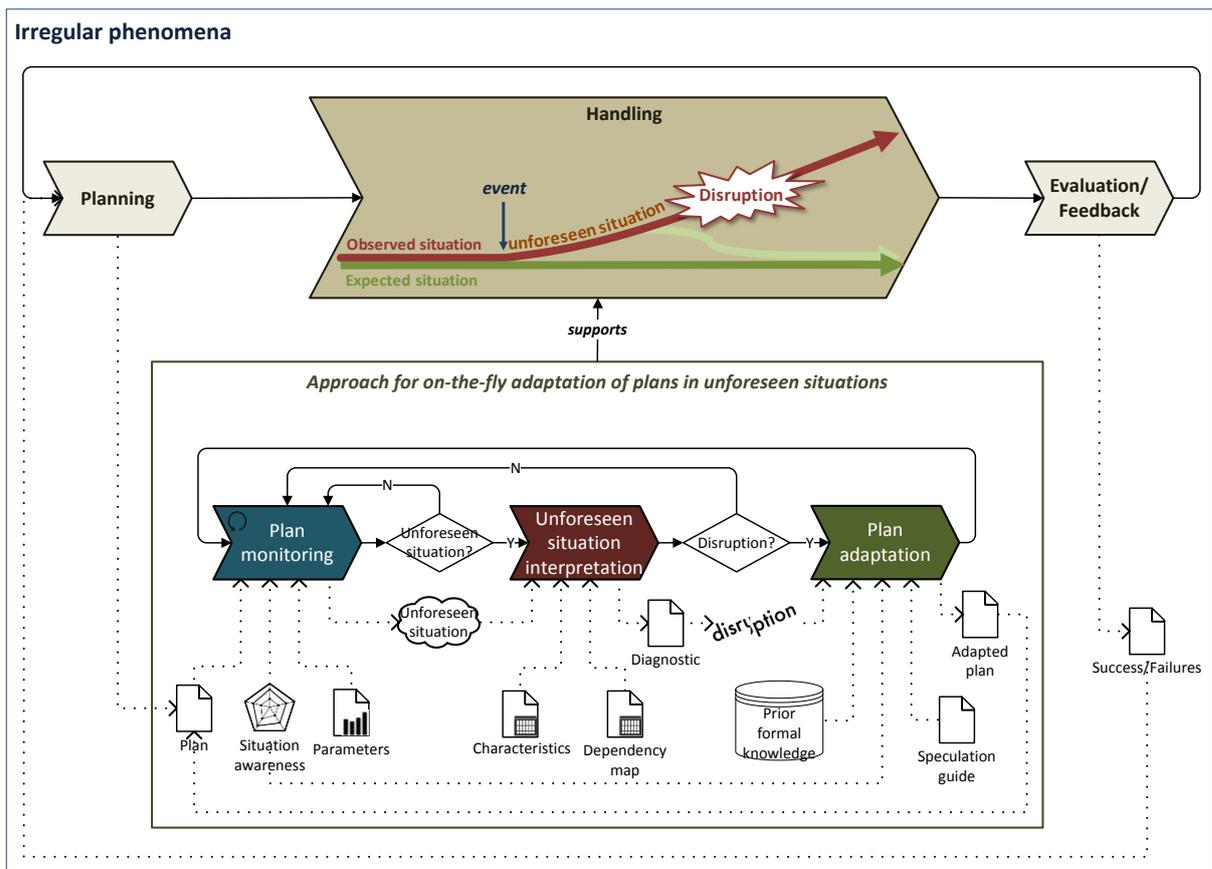


Figure 4-1: Approach for on-the-fly adaptation of plans in unforeseen situations

4.2 Plan monitoring

During handling, the response team makes decisions and performs actions using the prior developed plan. When using this document, the response team knows who carries out specific actions, what resources (people, equipment, information etc.) are available for use, and how all actions should be coordinated. In parallel, the response team constantly updates the current conditions of handling with information about the phenomenon evolution and arising out from the plan application. This information represents the phenomenon observed situation and supports the prior developed plan application.

The step of plan monitoring comprises following the plan, considering the phenomenon observed situation and a set of pre-established parameters. When these three components are combined (plan, phenomenon observed situation and pre-established parameters), it is possible to assess how far the expected situation is from the faced reality. Combining these components allows identifying unexpected events and unforeseen situations, besides deciding if the plan can still be used during handling. Thus, it is necessary to understand the following components for performing the plan monitoring and identifying unforeseen situations (Figure 4-2):

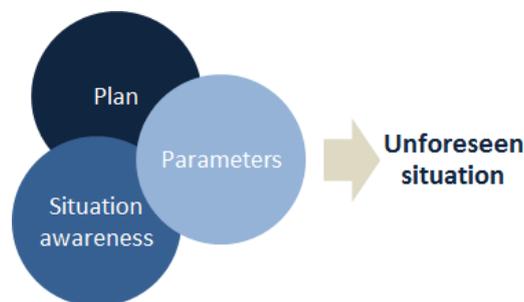


Figure 4-2: Components for plan monitoring

- **Plan:** Guides the decision-making and the execution of actions during handling;
- **Situation awareness:** Allows understanding the current conditions of the phenomenon handling. It has information about the phenomenon observed situation and the impact that the plan application has on it;
- **Parameters:** Help to evaluate if what is described in the plan is suitable for handling what is actually happening in reality (phenomenon observed situation).

4.2.1 Plan structure

The plan guides all actions and decisions taken by the response team during the phenomenon handling. Even with the diversity of representations used and the difficulty in formalizing plans in complex environments, it is possible to identify a set of common elements. Thus, this approach proposes the following main elements for describing plans (Figure 4-3):

- **Action,** which is an atomic task performed to achieve a goal. It aims to take the phenomenon from one state to another by changing the state variables values and uses different resources. It is expressed through the task to be performed, the goal to be achieved and the necessary resources to execute it;

- **State**, which characterizes the phenomenon at a specific moment. The state is expressed through a set of variables, which has associated values that may change over time. The state variables comprise people involved, required information, required systems, required material resource, existing restrictions, estimated elapsed time at that point of handling, estimated cost at that point of handling and expected action result;
- **Resource**, which comprises a set of elements that is necessary to perform an action. It comprises people, information, systems, equipment and restrictions;
- **Event**, which may occur during the phenomenon handling and has impact on the state variables;
- **Goal**, which defines what should be achieved during the phenomenon handling. It may have subgoals.

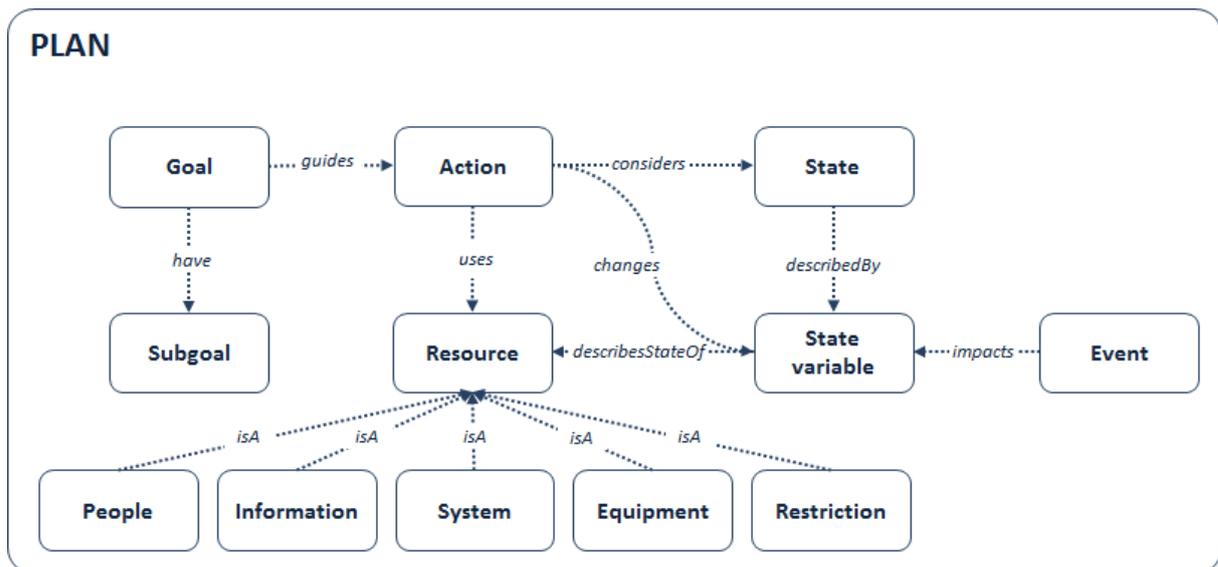


Figure 4-3: Conceptual framework of plan elements

4.2.2 Situation awareness characterization

The plan monitoring also requires attention to the current conditions of the phenomenon handling. Being aware of the phenomenon evolution allows the response team to decide what is the appropriate reaction in response to the observed situation. I.e. the observed situation is used to determine which parts of the plan should be performed at a specific moment to handle the phenomenon. The impact of the plan application and possible unexpected events should also be considered.

Thus, the following information should be captured for a specific analyzed moment to characterize the situation awareness:

- performed actions, to present the actions that have been taken and the actions that still needs to be performed;
- people involved, including information about the existing skills, available quantity, location and allocation;
- information, including which information are required, besides their update, reliability, completeness and availability;
- systems, including which systems are necessary and availability;
- material resources, including which material resources are necessary, available quantity, location and allocation;
- current restrictions;
- current duration of the handling;
- the real cost of the handling;
- the result of the last action, to assess if its expected results have been fully, partially or not attended;
- status of the final goal, to present if it was achieved or not;
- the occurrence of an unexpected event.

This information allows the response team having a broad view of the phenomenon observed situation and assessing if what is happening can still be handled by the selected plan.

4.2.3 Plan parameterizing

Identifying inconsistencies between what is described in a plan and what is actually happening uses pre-established parameters that ensure the treatment validity. Thus, it is necessary to determine these parameters to ensure that the suggested treatment is adequate to the faced reality. The proposed approach suggests the establishment of a set of critical state variables for the ongoing phenomenon.

Plan parameterizing also involves defining validity ranges. The response team must balance the strictness level adopted during the validity range establishment. If the validity range is too rigorous, it can generate more unforeseen situations and adaptation demands than actually necessary. If the validity range is too flexible, the selected plan may not be

effective when applied to the ongoing phenomenon. It is also argued that the validity range of non-critical variables can be more flexible than that established for the critical variables.

Both tasks are ideally performed during planning. However, it is important that the response team also revises these definitions during the phenomenon handling. Thus, the state variables and the established ranges remain valid for the current faced reality.

4.2.4 Unforeseen situations identification

Unforeseen situations are identified by comparing the values of state variables defined in the plan (phenomenon expected situation) and their actual values identified in the phenomenon observed situation. Each of these variables must be compared to determine if they are or are not defined within the established validity range.

It is proposed that this comparison starts from the critical state variables because they may generate more negative effects if not properly handled. After that, the values of noncritical variables should also be compared. If significant (as defined by the plan) variations are identified between the expected value and the observed value of the state variables, a more detailed analysis is required to determine if there is a need to adapt the plan.

An important observation is made about the state variable values. These values are not always used at the time they are collected. There may be an elapsed time between collecting, receiving and using such values (DINIZ et al., 2005). Thus, there may be differences between the known state variables value, i.e. the one used for the unforeseen situations identification, and their actual value. Therefore, the identification of unforeseen situations, and consequent diagnosis and adaptation, might be based on incorrect information from the beginning. Solving the highlighted issue is beyond the scope of this thesis.

4.3 Unforeseen situation interpretation

An unforeseen situation occurs when the phenomenon observed situation does not match the phenomenon expected situation. Thus, when an unforeseen situation is identified during the plan monitoring, the response team must understand what this new situation is and decide what actions need to be undertaken for handling the ongoing phenomenon.

The interpretation comprises the analysis of the identified unforeseen situation to understand if and how it affects the plan application in the ongoing phenomenon. It is necessary to understand the variations identified between the values defined in the plan and

in the unforeseen situation, besides verifying if the current conditions can handle such variations. Thus, it is possible to determine if adaptation procedures need to be triggered.

The unforeseen situation interpretation follows the proposed steps (Figure 4-4):

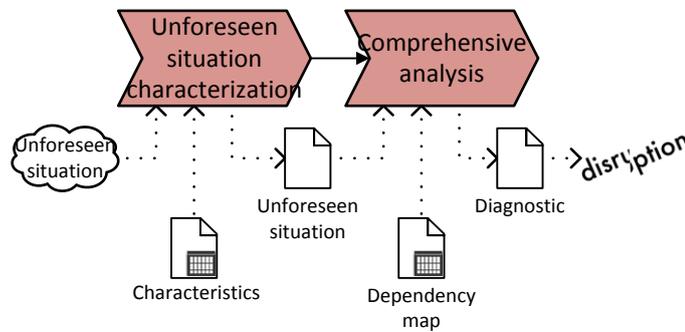


Figure 4-4: Unforeseen situation interpretation

- **Unforeseen situation characterization:** Identifying variations between the values estimated in the plan and the values in the unforeseen situation to determine the impact and type of the unforeseen situation;
- **Comprehensive analysis:** Assessing the dependency that a state variable has on others variables to evaluate if the current values of the related variables can handle the variation identified. Such analysis will indicate if the plan is still applicable or not in the unforeseen situation faced.

4.3.1 Unforeseen situation characterization

The interpretation begins with the characterization of the unforeseen situations that have affected a state variable. This characterization involves the retrieval of the state variables presenting variations between the values that are expected in the plan and the values in the unforeseen situation. After that, the response team determines the type of the unforeseen situation affecting the discrepant state variable. In addition, the impact that the unforeseen situation has over a state variable is also defined. Unforeseen situations may generate both positive and negative impacts on state variables. Table 4-1 shows the template adopted to characterize the unforeseen situations that may affect the state variables.

By considering the state variable (the first column of the table), the template shows a non-exhaustive list of possible unforeseen situations that may affect the state variable (the third column of the table) and the positive or negative impact that this unforeseen situation has on the state variable (the second column of the table). For instance, considering the state

variable “People involved”, the table shows six possible unforeseen situations affecting this variable (“Few people”, “No required skill”, “Allocated by another action”, “Not found”, “More people” and “Early deallocation”). For the unforeseen situation “Few people”, the table shows that this situation will cause a negative impact on this variable since if there are insufficient people, the response team will have extra work to do and it will be harder to handle the phenomenon. For the unforeseen situation “Early deallocation”, the table shows that this situation will cause a positive impact on the state variable since this person can be reallocated in another action that may require an extra help.

Table 4-1: Unforeseen situations affecting state variables

State variable	Unforeseen situation	State variable	Unforeseen situation
People involved	- Few people	Required material resources	- Absence
	- No required skill		- Allocated by another action
	- Allocated by another action		- Broken
	- Not found		- Not found
	+ More people		- Lack of requirements
	+ Early deallocation		- Out of date
Required information	- Absence	Estimated elapsed time	+ More material resources
	- Out of date		+ Early deallocation
	- Unstructured	Estimated cost	- Expired
	- Incomplete		+ Available
- Not reliable	Expected action result	- Lack of money	
- Absence		+ More money	
- Not working		- % lower than expected	
- Lack of requirements		+ % higher than expected	
Required systems	- Out of date	Existing restrictions	- Unable to perform action
	+ More systems		- Unable to use resource

4.3.2 Comprehensive analysis

After the unforeseen situations characterization, a comprehensive analysis of the state variables is performed. It considers the impact that the state variables affected by the unforeseen situations have on other state variables and is supported by a dependency map, shown in Table 4-2.

By considering the state variable that was affected by some unforeseen situation (the first column of the table) and the positive/negative impact that this unforeseen situation has (the second column of the table), the dependency map shows the positive or negative effects that the variation in the affected state variable has on other state variables. For instance, considering the variable “Required material resources” and an unforeseen situation causing a

negative impact on this variable, the table shows negative effects on state variables “People involved”, “Estimated elapsed time”, “Estimated cost” and “Expected action result”. I.e. if there are insufficient material resources, people involved will have extra work to do, time and cost to handle the phenomenon will be greater, and it will be harder to achieve the expected action results.

A disruption is reported when some related variable is critical or the observed values of the related variables cannot handle the variation caused by the unforeseen situation.

Table 4-2: Dependency map

		Related state variables							
		People involved	Required information	Required systems	Material resources	Existing restrictions	Elapsed time	Estimated cost	Action result
Affected state variable	People involved	+					+		
		-		-	-	-	-	-	-
	Required information	+							
		-	-		-	-	-	-	-
	Required systems	+							+
		-	-	-			-	-	-
	Material resources	+					+		
		-	-				-	-	-
	Existing restrictions	+							
		-	-	-	-	-	-	-	-
	Elapsed time	+	+	+					
		-	-	-					-
	Estimated cost	+	+			+			
		-							
	Action result	+	+		+	+	+	+	
		-	-	-	-	-	-	-	

4.4 Plan adaptation

Whenever the identified unforeseen situation leads to a disruption in the existing plan, adaptation procedures become necessary. The plan adaptation aims to develop and select an alternative solution to deal with the reported disruption. According to this disruption, different types of plan adaptation may be demanded, ranging from making specific changes, where existing plan elements are repositioned or new elements are incorporated into the plan, to a complete plan revision, when the existing plan is no longer valid. Thus, the response team uses the available knowledge for devising and selecting an alternative solution for handling the unforeseen situation.

The plan adaptation follows the proposed steps (Figure 4-5):

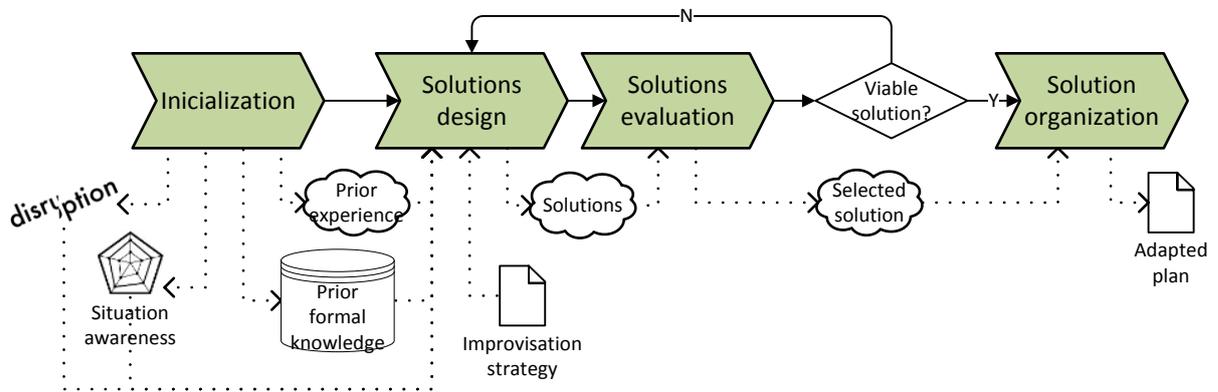


Figure 4-5: Plan adaptation

- **Initialization:** Understanding the disruption identified in the plan and the knowledge available to provide a solution for this disruption;
- **Solutions design:** Devising alternative solutions for handling the disruption based on the knowledge arising from the phenomenon evolution;
- **Solutions evaluation:** Evaluating the impact of using the identified solutions and selecting the most suitable solution to be applied to the ongoing phenomenon;
- **Solution organization:** Transforming the selected solution according to the proposed elements for plans representation.

4.4.1 Initialization

Initialization involves making visible the disruptions identified in the plan to the response team. The response team also needs to be aware of the knowledge available for adaptation. It comprises the selected plan, the situation awareness of the phenomenon, plans developed for similar phenomena, reports that describe how past phenomena were handled, personal experience in dealing with similar phenomena etc. This information may be stored at a supporting tool or external knowledge base, besides being provided by the members of response team.

4.4.2 Solutions design

The response team may apply an existing and evaluated plan to provide a solution for the faced disruption. This alternative plan may be retrieved from a prior formal knowledge

base (Figure 4-6). The definition of the best strategy used to recover such alternative plan is beyond the scope of this thesis.

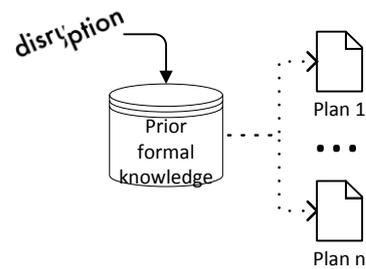


Figure 4-6: Retrieving plans from a prior formal knowledge base

However, it is not always possible to find an existing plan that presents a solution for the faced disruption. When the prior formal knowledge base fails to provide a solution for the disruption, improvisation is adopted. It will be performed until providing a solution that allows (a) achieving the established goal or (b) reaching a known situation that enables the use of an existing plan that may be applied. For this, the response team should be able to create new connections between the available resources and between these resources and its own experience in other phenomena to devise a set of possible solutions for the disruption (Figure 4-7). The definition of an improvisation strategy/mechanism to provide a solution for the identified disruption is beyond the scope of this thesis.

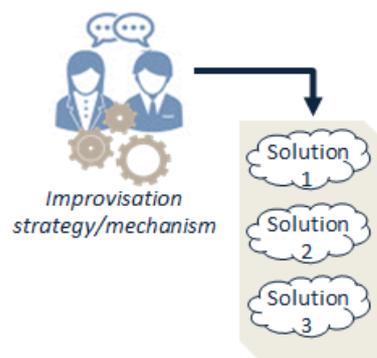


Figure 4-7: Alternative solutions improvisation

4.4.3 Solutions evaluation

The response team evaluates the identified solutions to select the most suitable one to be adopted. For this, the approach proposes to make visible the consequences arising from solutions application. Based on the requirements for performing some solution, the impact that this solution has on the phenomenon observed situation will be presented to the

response team. This team will be responsible for evaluating and selecting which solution is the most suitable to be applied.

During this evaluation, the response team may determine that a given solution will not provide the expected effects. If it happens, this solution can be discarded. If none of the identified solutions is adequate for handling the disruption, it is necessary to return to the “solutions design” phase to find new ways to handle the disruption.

It is important to highlight that defining the most suitable solution is influenced by who is evaluating the available options. This person may consider that the best solution is the one that will lead to fewer future adaptations, the first developed one etc. Thus, the criteria used for this evaluation is beyond the scope of this thesis.

4.4.4 Solution organization

A solution for the faced disruption may be identified from existing plans that, as mentioned before, are described through a variety of representations. Besides that, it may also be identified from prior experiences, i.e. tacit knowledge, which may make this solution incomplete and/or lacking the appropriate structure for the immediate application. Thus, the chosen solution must be organized according to the plan elements before it is applied. The response team should analyze this solution so they can identify the proposed plan elements and represent the solution through them. Therefore, the adapted plan is produced and can be applied in the faced disruption (Figure 4-8).

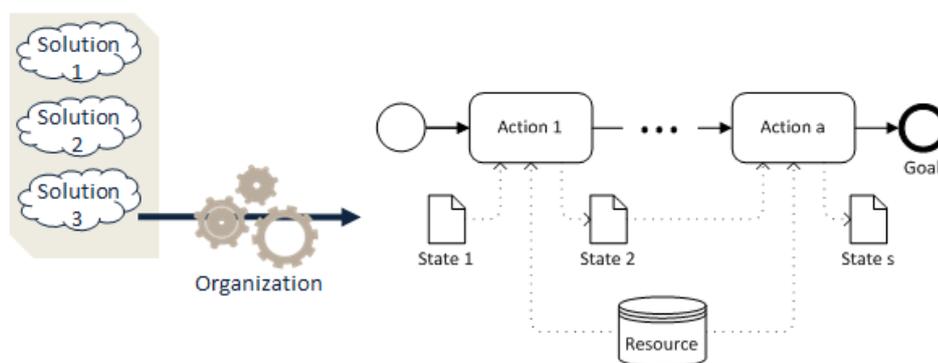


Figure 4-8: Organizing the improvised solution using the proposed plan elements

4.5 Final comments

The proposed approach suggests the use of the knowledge arising from the phenomenon evolution, which is identified during execution and/or concerns the prior

experience in similar phenomena, for the on-the-fly adaptation of plans in unforeseen situations. This knowledge allows the response team to adjust prior developed plans when the phenomenon observed situation does not match the expected one. It supports the identification of unforeseen situations, the diagnosis of their impact on the existing plan and the adjustment of plans that become inappropriate for handling the ongoing situation.

It is argued that the approach provides a more systematic way to handle unforeseen situations, besides a wider support to decision-making when dealing with the on-the-fly adaptation of plans in complex environments. It provides mechanisms for using explicit and tacit knowledge about the irregular phenomenon to support the diagnosing and handling of unforeseen situations, making the plan becomes more suitable and effective for handling the real situation faced.

5 Computational support

This chapter details the tool to support the on-the-fly adaptation of plans when identifying unforeseen situations during irregular phenomenon handling. It describes the tool design and available features.

5.1 Introduction

The last chapter has presented the approach for on-the-fly adaptation of plans in unforeseen situations. To support the proposed approach, a computational tool is required. Such tool must provide mechanisms that addresses (Figure 5-1):

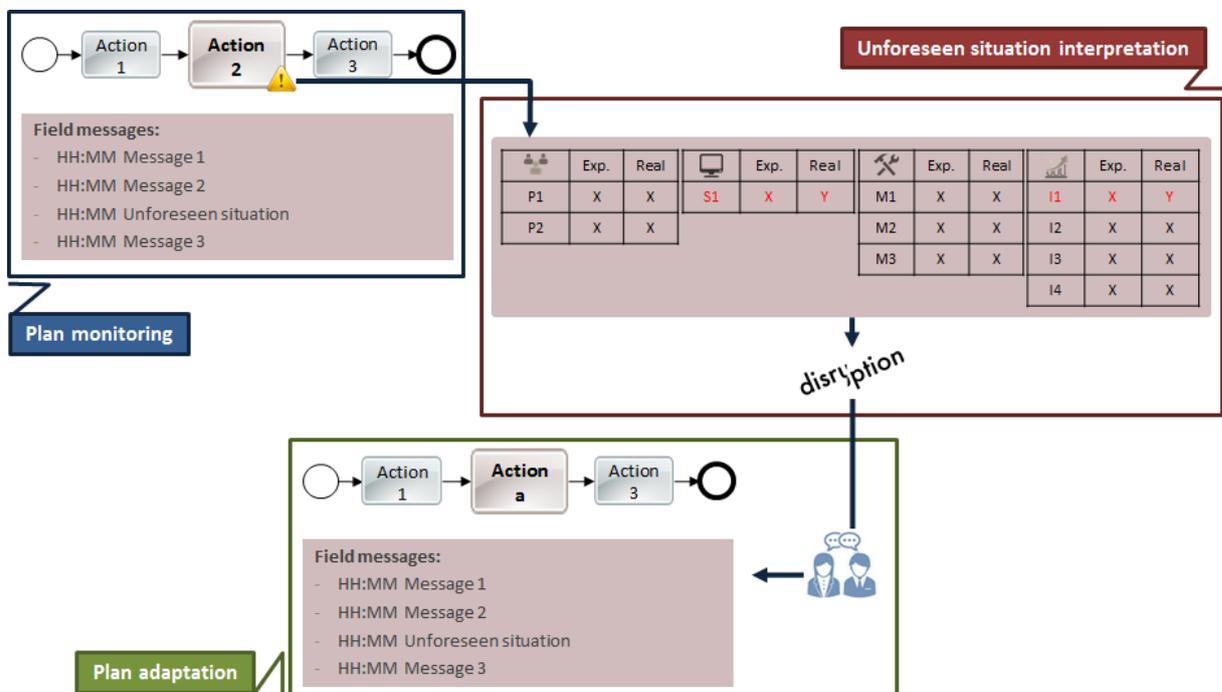


Figure 5-1: Features provided by the computational tool for on-the-fly adaptation of plans in unforeseen situations

- **Plan monitoring:** The response team monitors the existing plan and is aware of updated information about the irregular phenomenon observed situation to identify unforeseen situations;
- **Unforeseen situation interpretation:** The response team uses the available information to diagnose if the identified unforeseen situation has produced a disruption in the existing plan;

- **Plan adaptation:** The response team uses the knowledge arising from the irregular phenomenon evolution to design a solution for the reported disruption and make the plan able to handle the unforeseen situation.

5.2 Plan monitoring

During handling, the response team makes decisions and performs actions according to the prior developed plan and the phenomenon observed situation. This information helps the response team to assess how far the phenomenon expected situation is from the observed situation, thus identifying unforeseen situations. Therefore, considering the explanation provided in section 4.2, a supporting tool must meet the requirements detailed in Table 5-1.

Table 5-1: Requirements for plan monitoring

Feature	Description
Plan configuration	The tool stores the plan details using the proposed elements (actions-states-resources-events-goal). Besides that, to ensure that the suggested treatment is suitable for the observed situation, the tool also allows the establishment of the set of critical state variables and the validity range for this plan.
Scenario configuration	The tool stores information about the scenario used in the experiment and its pre-defined unforeseen situations.
Plan monitoring	The tool shows the plan so that the response team can use it to guide the actions and decisions taken during handling.
Situation monitoring	The tool shows the information about the phenomenon observed situation so that the response team can identify unforeseen situations and plan incompatibilities.
Generation of situation awareness	The tool performs a comparison between the plan, the phenomenon observed situation and the pre-established parameters and shows the result of this comparison to the response team.
Unforeseen situations proposal	The tool stores the unforeseen situations identified during (a) the development of the scenario used in the experiment and (b) the technical specialist's analysis of the phenomenon observed situation. The tool presents these unforeseen situations to the response team.
Unforeseen situation recording	The tool stores the unforeseen situations identified by the response team.

When accessing the tool, the response team finds the monitoring screen (Figure 5-2). On this screen, the response team has access to the plan details and information about the phenomenon observed situation².

² All examples use the scenario adopted in the experiment. For more details, see section 6.3.

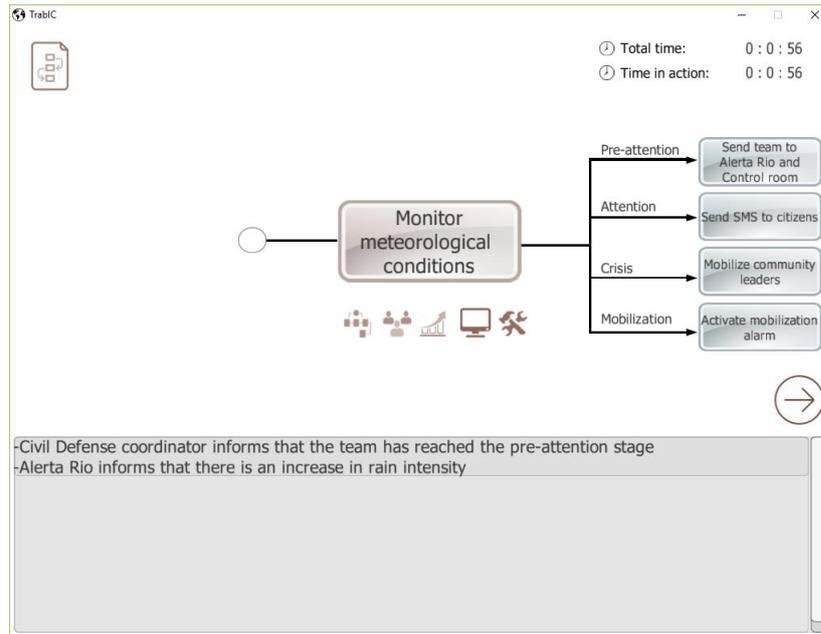


Figure 5-2: The monitoring screen

Regarding the plan, the response team finds details of the planned procedures to be applied during the phenomenon handling. This plan follows the elements proposed by the approach (actions-states-resources-events-goal), although not all elements are explicitly visible on the tool interface. The tool displays the point of the plan being executed (current running action – Figure 5-3a), besides an overview of what was performed immediately before the current action (Figure 5-3b) and what will be performed right after this action conclusion (Figure 5-3c).

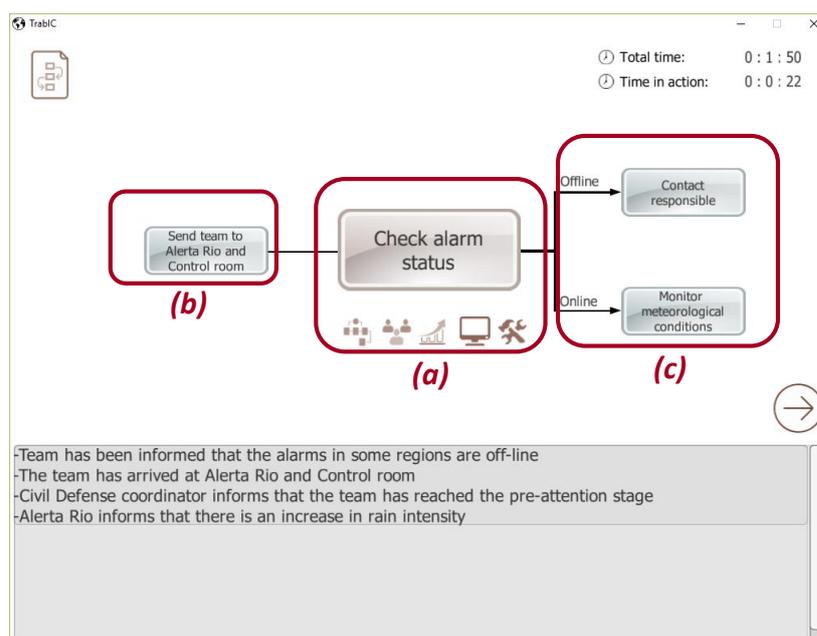


Figure 5-3: Overview of the existing plan

If the response team wants to access the full plan, it can click on the button located on screen (Figure 5-4a). The tool shows the existing plan, highlighting the point of the plan being executed (current running action) (Figure 5-4b).

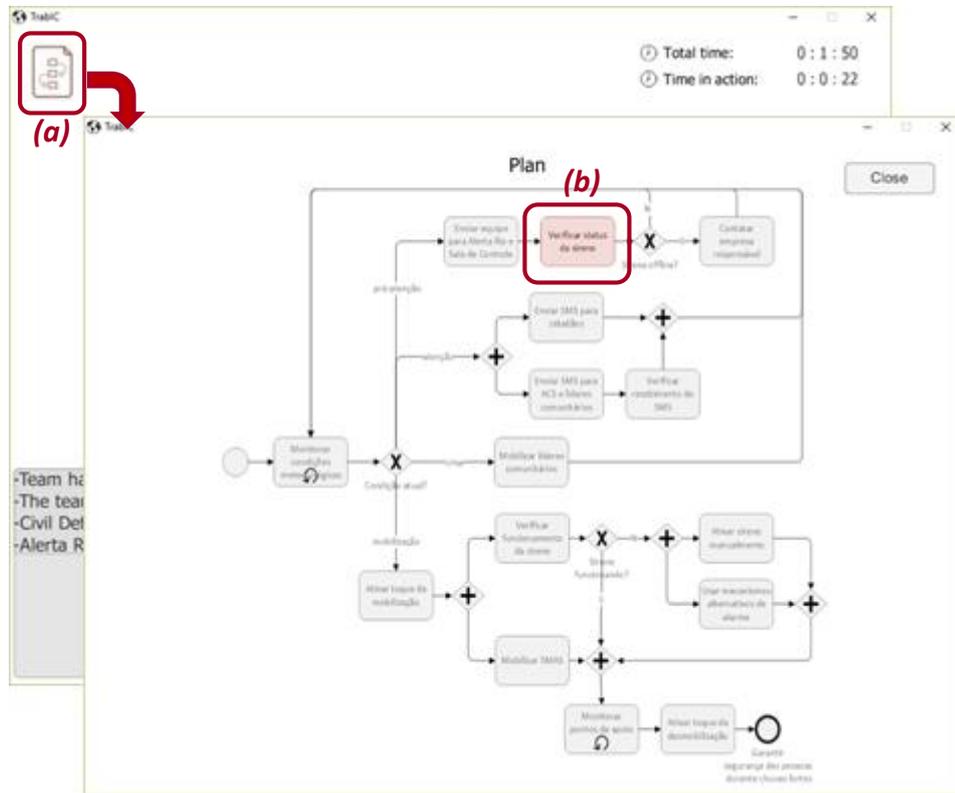


Figure 5-4: Full plan visualization

The response team also finds additional information about the current action by using the buttons located below it, such as textual description, people involved, required systems, required material resource and required information (Figure 5-5a). When the response team clicks on these buttons, it finds out the state variables monitored during the action execution, besides the expected and real values of each state variables (Figure 5-5b).

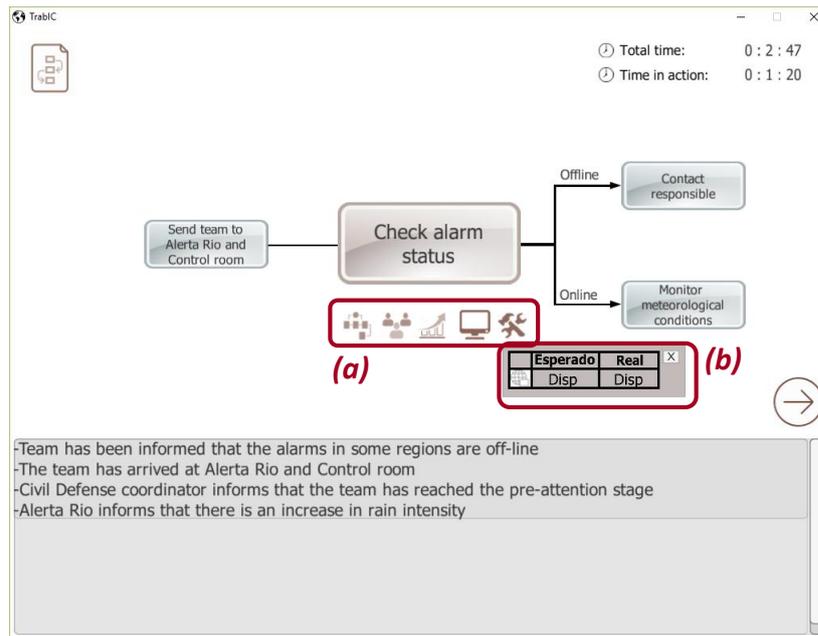


Figure 5-5: Additional information about the current action

When deciding that the current running action has been completed, the response team can set the plan to the next action to be performed (Figure 5-6).

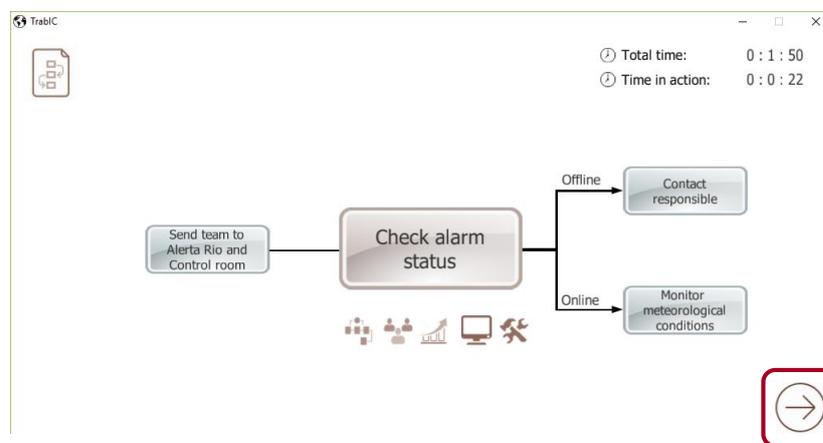


Figure 5-6: Moving within the plan

Regarding the phenomenon observed situation, the response team in control room receives information sent by the response teams on the field (situation awareness) (Figure 5-7). These messages provide an overview of what is actually happening during the phenomenon handling and help the response team in control room to decide what is the appropriate reaction in response to the phenomenon observed situation.

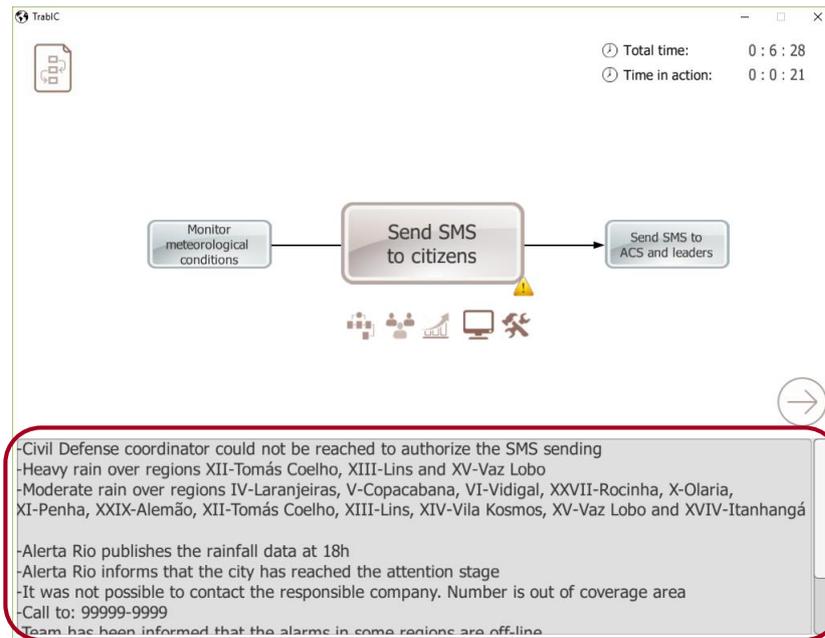


Figure 5-7: Overview of phenomenon observed situation

These messages also help to ensure whether the suggested treatment is still suitable for the phenomenon observed situation or an unforeseen situation was identified. The response team can identify unforeseen situations through this message area (Figure 5-8).

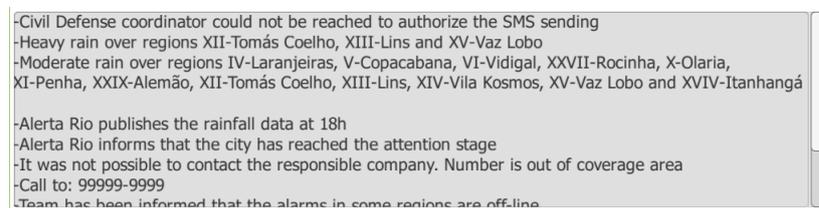


Figure 5-8: Proposed unforeseen situations in message area

The buttons below the current action also provide additional information about the phenomenon observed situation. When clicking on these buttons, the response team finds out the actual values of each state variable monitored by this action (Figure 5-9).

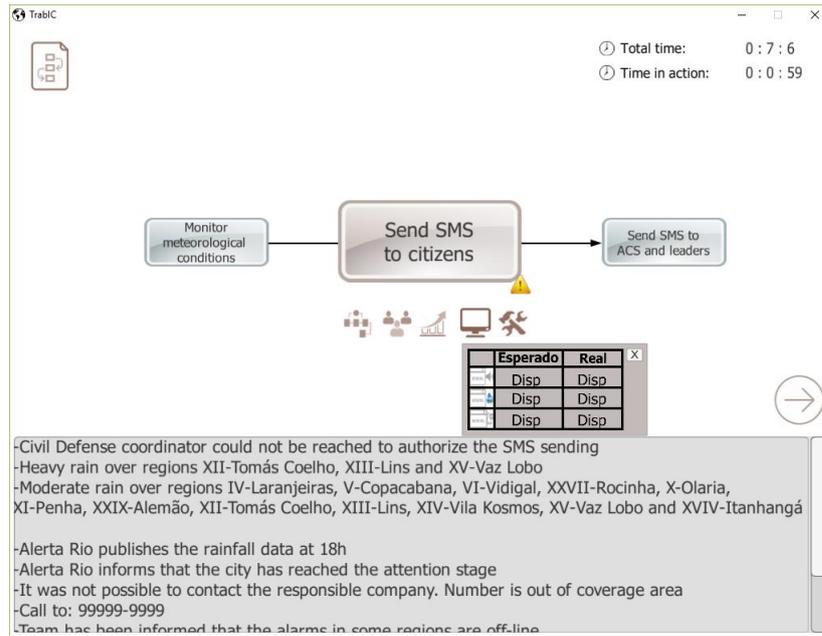


Figure 5-9: Additional information about the phenomenon observed situation

The response team also needs to control how much time this team is spending on the phenomenon handling. The tool provides information about the total duration of the phenomenon handling and for performing a specific action (Figure 5-10).

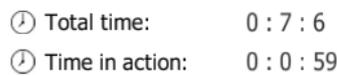


Figure 5-10: Control of handling duration

A set of critical state variables and the validity range for the plan are established. These values will be used during the automatic comparison between the plan (expected values), the phenomenon observed situation (actual values) and the pre-established parameters to ensure that the suggested treatment is still suitable for the observed situation. According to the comparison result, the tool provides perception mechanisms to evidence the occurrence of an unforeseen situation (Figure 5-11).



Figure 5-11: Perception mechanisms

The tool also stores the proposed unforeseen situations.

5.3 Unforeseen situation interpretation

After identifying an unforeseen situation, the response team must understand what this situation is and decide if and how it affects the plan application. Thus, considering the explanation provided in section 4.3, a supporting tool must meet the requirements detailed in Table 5-2.

Table 5-2: Requirements for unforeseen situation interpretation

Feature	Description
Pre-diagnosis assessment	The tool provides recommendations for unforeseen situation characterization and indicates that this situation has produced or not disruptions in the plan to the response team. Besides that, the tool also supports the response team to assess the available information and adjust them if something is incorrect/inappropriate.
Diagnosis recording	The tool stores the diagnosis of the unforeseen situation, comprising (a) the unforeseen situation faced; (b) if this unforeseen situation has led or not to a plan disruption; and (c) if so, what should be done to solve the disruption.

The response team can click on the perception mechanism to access the unforeseen situation analysis screen (Figure 5-12).

Figure 5-12: The unforeseen situation analysis screen

On this screen, the response team finds out the expected and actual values of each state variables monitored by the action (Figure 5-13). This information provides an overview of what is actually happening during the phenomenon handling.

Expected	Real	Changed
Disp	Disp	Disp
Disp	Indisp	Indisp

Expected	Real	Changed
Pré-ate	Pré-ate	Pré-ate
55	12	12
Disp	Disp	Disp
On	Off	Off

Expected	Real	Changed
Disp	Disp	Disp
Disp	Disp	Disp

Expected	Real	Changed
Disp	Disp	Disp
Disp	Disp	Disp

Figure 5-13: Overview of the expected and actual values of state variables/resources

According to these values, the response team can diagnose the unforeseen situation. I.e., defining the unforeseen situation faced; if this unforeseen situation has led or not to a plan disruption; and, if so, what should be done to solve the disruption (Figure 5-14). The response team may also decide that, despite the unforeseen situation occurrence, nothing needs to be changed.

Unforeseen situation:

Does it produce a significant plan change? Yes

Solution:

Figure 5-14: Unforeseen situation diagnosis

The tool also stores the unforeseen situation diagnosis, comprising the unforeseen situation faced; if this unforeseen situation has led or not to a plan disruption; and the solution provided to continue the handling (Figure 5-15).

```

-----
Cena atual: 1.4.1-VerificarSirene
Data atual: 2016.11.11 11:28:53 AM
Tempo total: 0 : 1 : 44.03737
Tempo na cena atual: 0 : 0 : 31.40317
-----
Situação identificada na cena: 1.4.2-ContatarEmpresa
Na data/hora: 2016.11.11 11:34:39 AM
-----
Tempo Total:0 : 7 : 30.36876
Sirene não funcionando
Sim
Agente no local fazer um acionamento manual se for necessário E avisar os voluntários da
comunidade sobre a aproximação de chuva mais forte e se necessário direcionarem para ponto de
apoio e casa de amigos.
Pessoas envolvidas na operação
Ideal: Disp | Real: Disp | Corrigido: Disp
Ideal: Disp | Real: Indisp | Corrigido: Indisp
Ideal: Disp | Real: Disp | Corrigido: Disp
Ideal: Disp | Real: Disp | Corrigido: Disp
Ideal: 5 | Real: 5 | Corrigido: 5
Ideal: 8 | Real: 8 | Corrigido: 8
Sistemas envolvidos na operação
Ideal: Disp | Real: Disp | Corrigido: Disp
Equipamentos envolvidos na operação
Ideal: Disp | Real: Disp | Corrigido: Disp

```

Figure 5-15: Diagnosis stored in the tool log

5.4 Plan adaptation

Whenever the identified unforeseen situation leads to a disruption in the existing plan, adaptation procedures become necessary. Thus, considering the explanation provided in section 4.4, a supporting tool must meet the requirements detailed in Table 5-3.

Table 5-3: Requirements for plan adaptation

Feature	Description
Plan navigation	The tool allows setting the plan monitoring to the most appropriate point of the plan for handling the disruption faced.
Available awareness knowledge	The tool shows to the response team the disruptions and the knowledge that support adaptation, including the resources available, the situation awareness, plans developed for similar phenomena, reports that describe how past phenomena have been treated, personal experience in handling similar phenomena etc.
Existing solutions identification	The tool supports the identification and evaluation of the existing and evaluated plans, besides the selection of the most appropriate plan to be followed.
Solutions improvisation	The tool supports the recombination of available resources through improvisation to provide a set of possible solutions for the disruption. The response team evaluates these solutions and selects the most appropriate to be followed during the phenomenon handling.
Solutions organization	The tool supports the organization of selected solution according to the proposed plan elements before applying it.
Plan update	The tool stores the adapted plan, which should be followed during the phenomenon handling.

At this moment, the provided features for the plan adaptation are restricted to the description of possible solutions for disruptions (Figure 5-14) and the modification of values assumed by the state variables monitored by the action (Figure 5-16). For the latter, the response team can suggest new values to the state variables according to its analysis of what is actually happening during the phenomenon handling. These new values are used while performing next actions and decision-making.

Expected	Real	Changed
Disp	Disp	Disp
Disp	Indisp	Indisp

Expected	Real	Changed
Pré-ate	Pré-ate	Pré-ate
55	12	12
Disp	Disp	Disp
On	Off	Off

Expected	Real	Changed
Disp	Disp	Disp
Disp	Disp	Disp

Expected	Real	Changed
Disp	Disp	Disp
Disp	Disp	Disp

Figure 5-16: Modification of state variables values

Besides the features detailed above, the tool must also provide other features to fully support the approach for on-the-fly adaptation of plans. The first feature is the plan navigation. The response team should be able to set the plan monitoring to the most appropriate point of the plan for handling the disruption faced.

Besides disruptions, resources available and phenomenon observed situation, the response team must also have access to other knowledge that supports adaptation, including other plans developed for similar phenomena, reports that describe how past phenomena have been treated, personal experience in handling similar phenomena etc. This must be stored in some knowledge base, thus allowing their retrieval, evaluation and use as a possible solution for the disruption faced.

Solution improvisation is also a task to be supported. The response team should be able to recombine the available resources, thus providing a set of possible solutions for the disruption, evaluating the developed solutions and selecting the most suitable to be applied.

The tool must also support the organization of selected solution according to the proposed plan elements and store the adapted plan, which should be followed during the phenomenon handling.

5.5 Final comments

This chapter has detailed the computational tool to support the on-the-fly adaptation of plans in unforeseen situations. Such tool provides mechanisms to support the identification and interpretation of unforeseen situations in the ongoing irregular phenomenon, besides an initial attempt to adjust the plan that become inappropriate to be followed when a disruption was identified. A summary of the main features can be found in Table 5-4.

Table 5-4: Tool main features

	Feature	Description	Developed?
<i>Plan monitoring</i>	Plan configuration	The tool stores the plan details using the proposed elements (actions-states-resources-events-goal). Besides that, to ensure that the suggested treatment is suitable for the observed situation, the tool also allows the establishment of the set of critical state variables and the validity range for this plan.	Yes
	Scenario configuration	The tool stores information about the scenario used in the experiment and its pre-defined unforeseen situations.	Yes
	Plan monitoring	The tool shows the plan so that the response team can use it to guide the actions and decisions taken during handling.	Yes
	Situation monitoring	The tool shows the information about the phenomenon observed situation so that the response team can identify unforeseen situations and plan incompatibilities.	Yes
	Generation of situation awareness	The tool performs a comparison between the plan, the phenomenon observed situation and the pre-established parameters and shows the result of this comparison to the response team.	Yes
	Unforeseen situations proposal	The tool stores the unforeseen situations identified during (a) the development of the scenario used in the experiment and (b) the technical specialist's analysis of the phenomenon observed situation. The tool presents these unforeseen situations to the response team.	Yes
	Unforeseen situation recording	The tool stores the unforeseen situations identified by the response team.	Yes
<i>Unforeseen situation interpretation</i>	Pre-diagnosis assessment	The tool provides recommendations for unforeseen situation characterization and indicates that this situation has produced or not disruptions in the plan to the response team. Besides that, the tool also supports the response team to assess the available information and adjust them if something is incorrect/inappropriate.	Partially
	Diagnosis recording	The tool stores the diagnosis of the unforeseen situation, comprising (a) the unforeseen situation faced; (b) if this unforeseen situation has led or not to a plan disruption; and (c) if so, what should be done to solve the disruption.	Yes

	Feature	Description	Developed?
<i>Plan adaptation</i>	Plan navigation	The tool allows setting the plan monitoring to the most appropriate point of the plan for handling the disruption faced.	No
	Available knowledge awareness	The tool shows to the response team the disruptions and the knowledge that support adaptation, including the resources available, the situation awareness, plans developed for similar phenomena, reports that describe how past phenomena have been treated, personal experience in handling similar phenomena etc.	Partially
	Existing solutions identification	The tool supports the identification and evaluation of the existing and evaluated plans, besides the selection of the most appropriate plan to be followed.	No
	Solutions improvisation	The tool supports the recombination of available resources through improvisation to provide a set of possible solutions for the disruption. The response team evaluates these solutions and selects the most appropriate to be followed during the phenomenon handling.	No
	Solutions organization	The tool supports the organization of selected solution according to the proposed plan elements before applying it.	No
	Plan update	The tool stores the adapted plan, which should be followed during the phenomenon handling.	Partially

6 Evaluation

This chapter presents the experiment conducted by the researcher to evaluate the approach for on-the-fly adaptation of plans in unforeseen situations. It establishes the research questions, data sources and metrics for the approach evaluation. The chapter also introduces the selected domain and details the protocol for conducting the experiment. Besides that, it details the results interpretation and findings.

6.1 Experiment design

The planned experiment aims to investigate how the proposed approach can help the response team to identify and interpret unforeseen situations at runtime (Figure 6-1). The selection of these two phases was due to the Civil Defense agents have considered these the most important phases to be evaluated.

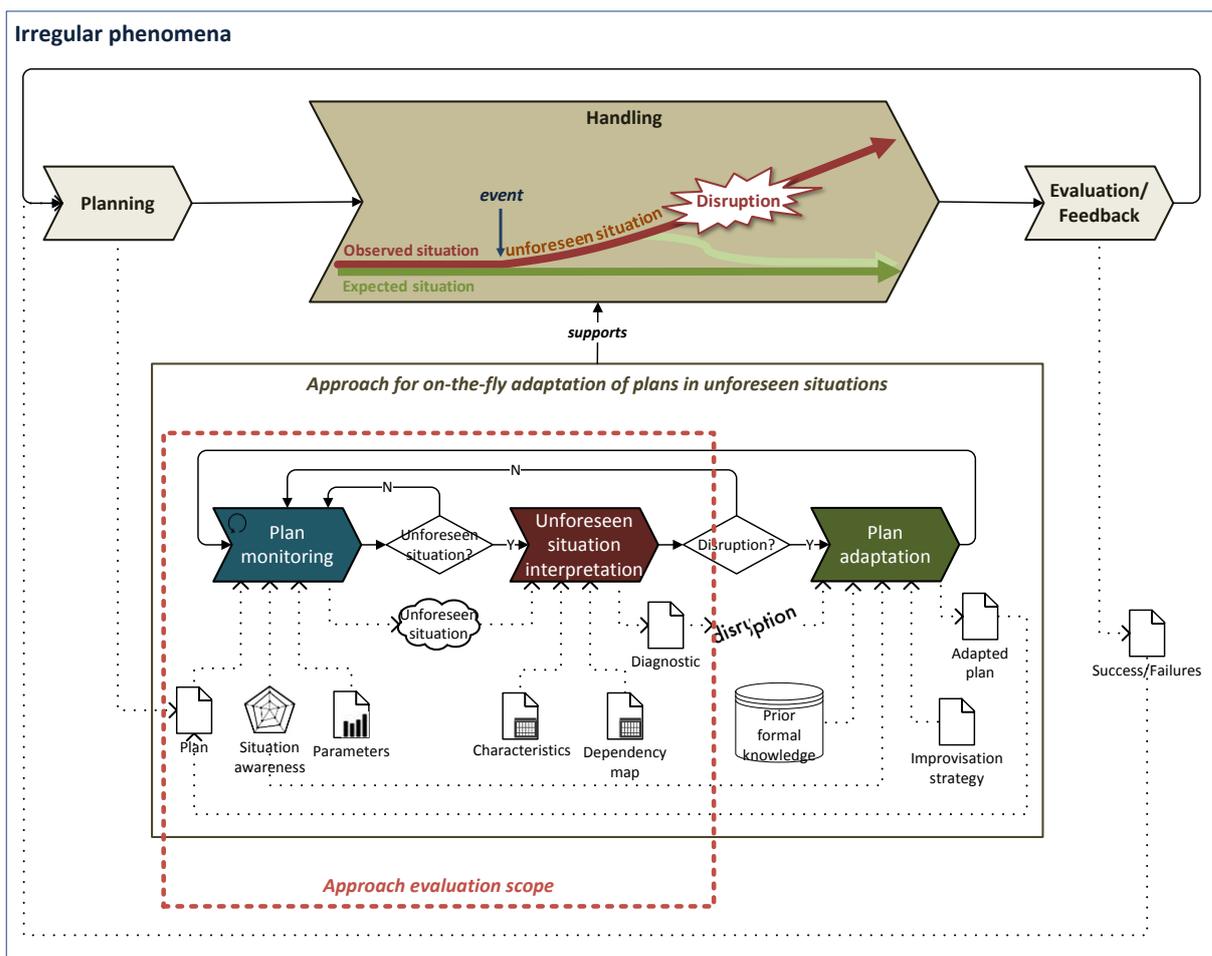


Figure 6-1: Approach evaluation scope

The information obtained during the experiment must answer the following research question:

- *RQ1: How the decision support mechanisms affect the response team's performance during the identification of unforeseen situations, considering the task difficulty?*
- *RQ2: How the decision support mechanisms affect the response team's performance during the interpretation of unforeseen situations, considering the task difficulty?*

The **decision support mechanisms** comprise the mechanisms detailed in the approach for on-the-fly adaptation of plans in unforeseen situations, such as the proposals for plan representation, plan parameterization, unforeseen situation characterization and dependency map, which are related to the diagnosis of unforeseen situations (identification + interpretation). The **team performance** will be measured in terms of effectiveness, i.e. the overall quality or amount of work accomplished by the response team, and efficiency, i.e. the output provided by the response team per unit of effort (GU and MENDONÇA, 2006). Both effectiveness and efficiency can be measured by analyzing the main outcome of diagnosis, i.e. the unforeseen situations. Measuring the response team's performance will consider the **task difficulty**, which is the level of difficulty to identify or solve the proposed unforeseen situation, i.e. an easy, medium or a hard situation considering the needed time, required effort and associated uncertainty (GRILL and HICKS, 2006 apud: LI et al., 2011).

Therefore, Table 6-1 presents the variables adopted in the experiment.

Table 6-1: Experiment variables

	Variable	Description
Independent	Decision support mechanisms (Approach/Process)	The mechanisms present in the proposed approach for on-the-fly adaptation of plans concerning the identification and interpretation of unforeseen situations.
Dependent	Team performance	Comprises a set of variables that enables to evaluate the response team's performance during identification and interpretation of unforeseen situations.
Controlled	Task difficulty	The level of difficulty to diagnose the proposed unforeseen situation (easy, medium or hard situation).

Table 6-2 details the dependent variable in terms of metrics used to evaluate the research questions.

Table 6-2: Evaluating the identification and diagnosis of unforeseen situations

	Variable	Measurement
RQ1	Percentage of proposed unforeseen situations	The ratio between the number of proposed unforeseen situations and the number of planned unforeseen situations.
	Percentage of identified unforeseen situations	The ratio between the number of identified unforeseen situations and the number of proposed unforeseen situations.
	Duration of detection	Time elapsed between the unforeseen situation occurrence and the identification of this situation by the participants.
	Discrepancy degree for unforeseen situation analysis	The difference between the expected and observed values of the state variables that characterize an unforeseen situation demanding further analysis.
RQ2	Duration of diagnosis	Time elapsed between the unforeseen situation identification and the establishment of a disruption by the participants.
	Quality of disruption establishment	Comparison between the expected result of the comprehensive analysis of the proposed unforeseen situation and the result established by the participants.
	Total of solutions	Number of solutions provided by the participants for the disruption.
	Proximity factor between solution and disruption	The ratio between the number of solutions which content is related to the identified disruption and the number of solutions.

6.2 Evaluation domain: Emergency management

The domain selected as the object of study and evaluation of the approach proposed in this thesis is the emergency management. Emergency management is more than just a response to a hazardous event; it is a systematic process that aims to minimize the negative impact and consequences of adverse events on people or properties. I.e. it is not always possible to prevent the occurrence of emergencies, but its effects can be minimized. An emergency is a complex, unforeseen and not completely anticipated phenomenon (LEY et al., 2014; VUSSC, 2008). It begins with an actual or imminent occurrence of an event, which requires immediate attention, and usually mobilizes many people that may be geographically dispersed, are from different organizations, use a variety of resources, and must deal with heterogeneous and often incomplete or partial data (DI MAIO, 2008; LEY et al., 2014; MARCHESI et al., 2008; STEEL et al., 2008).

The emergency management can be presented as a cyclic process (Figure 6-2) composed of three phases: (a) **pre-disaster**, which starts before an emergency event; (b) **response**, which starts when a dangerous situation arises from the emergency event, requiring immediate action; and (c) **post-disaster**, which starts when the emergency is

controlled (HADDOW et al., 2011; KHAN et al., 2008; VUSSC, 2008; WAUGH, 2000). One phase of the cycle does not have to be completed for the next phase to begin; several phases may occur simultaneously (VUSSC, 2008).



Figure 6-2: Emergency management cycle

During **pre-disaster**, policies and actions to reduce the vulnerability of a population or minimize the adverse effects of future emergencies are defined (HADDOW et al., 2011; KHAN et al., 2008; PENADÉS et al., 2011). For this, it is necessary to perform actions of **mitigation** and **preparedness**.

During **mitigation**, planning teams prospect long-term actions to prevent the occurrence of emergencies. It includes identification of potential emergencies, equipment procurement, obtaining financial resources, vulnerability analysis, etc.

During **preparedness**, the planning team *plans* how a specific emergency should be handled. It devises and generates an emergency plan by using the prior knowledge this team has about a potential emergency. The planning team is responsible for the identification and prioritization of all applicable hazardous events. This prioritization is necessary because organizations have limited funds, so their full spectrum of equipment, resources and trained staff need to focus on emergencies that might actually happen. The planning team designs norms and procedures that, if followed, should make the emergency evolve to an expected situation, returning the affected environment to a stable condition with minimum losses. It is also necessary to identify equipment, resources and trained staff that may be recruited when an emergency occurs. This includes the identification of outside resources that may be called upon in times of need. In addition, it is important to understand the vulnerabilities. It helps the planning team to understand why emergencies occur, where they are most likely to have

the greatest impact and what should be the proper response (HADDOW et al., 2011; PENADÉS et al., 2011).

In addition to the emergency plan development, the preparation counts on *training* activities. These activities aim to assess how the procedures, resources and emergency teams respond to the imagined situations. From exercises, such as the exercises performed by Eletrobras (2013) and Civil Defense (SUBDEC, 2016a), it is possible to determine if the procedures for a specific situation are the most appropriate and effective to control the emergency and if all addressed events and situations are described in the plan. Thus, training allows identifying the need for changes in procedures, resources acquisition or performing new training (HADDOW et al., 2011).

During the **response**, the response team performs actions to reduce the negative effects caused by the emergency. First, the response team carries out a phase of **alert**. They apply actions to prevent that the identified event does not turn into an emergency. Preventive actions are stimulated, for instance, window coverings in hurricanes, sirens activation in hazardous areas during rainstorms, roads interdiction in case of windstorms, etc.

If the emergency evolves to a dangerous situation, causing negative effects and requiring immediate action, the **response** is effectively initiated. In this phase, there is the involvement of governmental organizations, non-governmental organizations, the private sector and society. They may act on (a) the emergency control team, which manages the information coming from different sources and people working in the affected area; and/or (b) the operation team, which is in the field to handle the emergency, as firefighters, paramedics, bystanders etc. (HADDOW et al., 2011; PADILHA et al., 2010). The emergency teams make decisions and perform actions, which may be strategic, tactic or operational (LINDELL et al., 2006), based on the developed emergency plan (GÓMEZ et al., 2012; HADDOW et al., 2011; KHAN et al., 2008; LLAVADOR et al., 2006). The decision to use a specific emergency plan is based upon an assessment of the potential impacts of the emergency and the courses of action needed to eliminate or, at least, mitigate this impact (MENDONÇA et al., 2003). In addition to the emergency plan, the emergency response team also bases their decisions and actions on what is happening during the emergency evolution. This is provided by the analysis of the situation awareness information. As there is a gap between retrieving, analyzing and using the information about emergency evolution (DINIZ et al., 2005), the

emergency response team decides what should be done to handle the emergency by gathering a view of what is happening (observed situation).

During the **post-disaster**, the response team aims to return what has been affected to the conditions that it had before the emergency and to evaluate the actions taken during the response (HADDOW et al., 2011; KHAN et al., 2008; PENADÉS et al., 2011). Therefore, it is necessary to take actions for **recovery** and **replanning**.

During **recovery**, the response team performs actions to repair and rebuild what was lost during the emergency. It can take weeks, months or even years to be concluded. For instance, in Hurricane Katrina, which occurred in 2005, actions for the establishment of normality in the affected region were still being performed in 2011 (KLEIN, 2013; NOLAN, 2011).

During the **replanning**, the response team assesses the actions taken during the emergency response. This team aims to identify what needs to be revised and improved for future response in similar emergencies.

Based on this explanation, this thesis highlights that the emergency management cycle (Figure 6-2) could be detailed and represented by Figure 6-3.



Figure 6-3: Emergency management cycle detailing

Given the volatile environment found during emergencies, where the response team must constantly adapt itself to unforeseen situations, the use of an emergency plan is not always straightforward. Developing emergency plans is a challenging task, due to the great number of possibilities to be considered during content generation. While elaborating the plan, the planning team tries to predict all possible events faced and the information needed to characterize and handle the situations arising from them. This is particularly difficult for situations involving unpredictable emergency evolution or unexpected consequences of

planned actions. Thus, it is common that the planning team only identifies a subset of all possible events that need to be addressed. In addition, the planning team may decide not to include a specific possibility in the developed emergency plan, even if it is known. Moreover, the planning team may provide an inadequate treatment for a specific event, either because the situation caused by its occurrence has never been experienced or because of the unpredictability and uncertainty associated with it. Furthermore, the emergency plan may also be described at a higher level of abstraction to not specialize how response teams should act.

Such decisions may prove inadequate only when the plan is applied to a specific emergency. Therefore, the response team may discover new variables and unexpected events that need to be handled only at enactment time. In addition, the decisions and actions performed also affect the emergency observed situation, leading the response team towards facing states that may not correspond to the states defined in the emergency plan. Moreover, even for known situations, different outcomes may be identified. As result, the emergency plan becomes inappropriate to be followed, making more difficult to handle the ongoing emergency. The response team should observe the response operation conditions, identify the goals to be achieved, use creativity and improvisation to identify alternative treatments and make decisions at runtime to handle the ongoing emergency (BARTHE-DELANOË et al., 2014; LEY et al., 2014; MENDONÇA and WALLACE, 2007).

Thus, the emergency management domain seems suitable for the proposed approach evaluation. This domain was chosen because it is considered a complex domain, more complete and with different characteristics when compared to other domains where irregular phenomena are identified. It is claimed that the questions, experiments and analyzes in emergency management lead to conclusions that can be applied, expanded or generalized to other domains.

6.3 Experiment execution

The proposed approach was evaluated by simulating the application of a plan to handle rains in Rio de Janeiro. This city is a region usually exposed to heavy rains and associated consequences due to its geographical characteristics. Furthermore, it is a metropolis that has suffered from disordered growth, having several constructions built in areas at elevated risk to landslides, such as hills and slopes. Damage is particularly acute during the summer months,

when heavy and/or prolonged rains hit the city, producing floods and landslides. Thus, the Civil Defense has established procedures for a quick and safe evacuation in case of rains to ensure the safety of people living in high-risk areas (SUBDEC, 2015a). Such plan was organized according to the proposed plan elements (Figure 6-4 and Appendix 1).

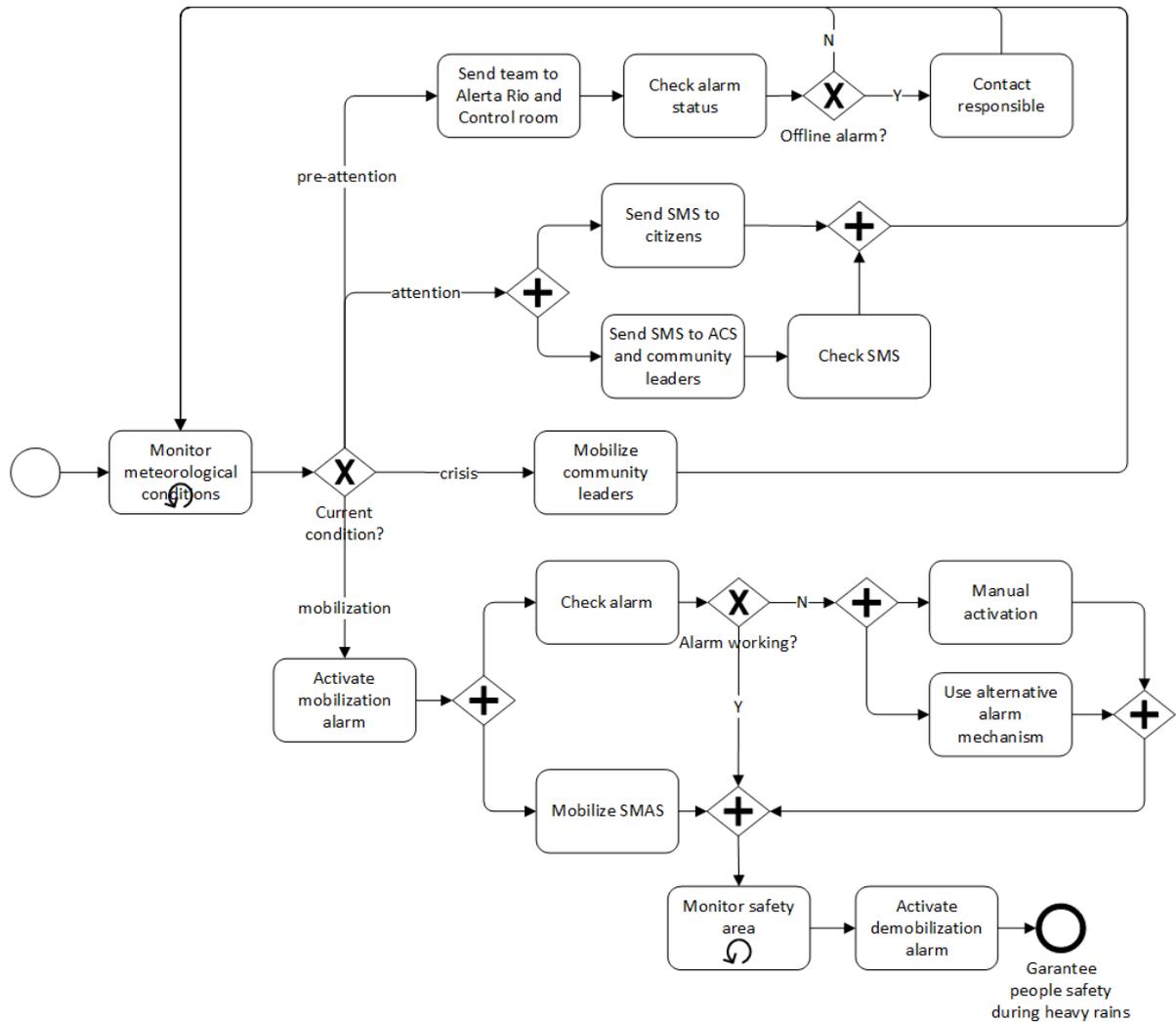


Figure 6-4: Contingency plan for heavy rains using BPMN (OMG, 2011)

To guarantee the validity of the phenomenon and the adopted plan within the selected domain, the researcher interviewed a team of domain experts for detailing this plan and devising a scenario before running the experiment. These two interviews occurred at (a) Coordenação do Sistema de Defesa Civil (COSIDEC) on 09/Aug/2016, and (b) Centro de Operações Rio (COR) on 12/Aug/2016.

During the plan detailing, these domain experts assumed the role of planners, providing additional information about what is usually done to handle the negative impact and consequences of heavy rains in Rio de Janeiro (SUBDEC, 2015b; SUBDEC, 2015c; Annex 1

and Annex 2). The goals to achieve, the actions to take, the necessary resources and the expected and resulting states from the actions execution were discussed. Appendix 1 details the contingency plan for heavy rains considering all collected information.

During the scenario devising, these domain experts assumed the role of scenario devisers, describing events and situations found during heavy rains, besides detailing a set of unpredicted events and unforeseen situations that might cause incompatibility of the existing plan. They also discussed problems that were faced by teams while handling heavy rains in Rio de Janeiro, besides providing historical information about rains that have hit Rio de Janeiro in the past (Annex 3 and Annex 4). The researcher organized all collected information, devising the scenario, described in Appendix 2, and the planned unforeseen situations, detailed in Appendix 3. The tool was configured with such information.

Experiment participants were also experts in the emergency domain. They work at Secretaria Municipal de Defesa Civil de Niterói or are members of Mestrado em Defesa e Segurança Civil. These participants assumed the role of the response team in control room, required for handling the emergency described in the scenario.

Besides participants, researchers and a technical specialist also attended the experiment. Researchers were responsible for conducting and observing the experiment, collecting data for later analysis and removing doubts concerning the experiment. The technical specialist provided the technical information that was necessary for running the experiment and proposed unpredicted events that lead to unforeseen situations for the participants. These events and unforeseen situations were those previously planned by the scenario deviser.

Table 6-3 summarizes the roles involved during the planning and execution of the experiment and details their responsibilities.

Table 6-3: Roles and responsibilities during the experiment

Roles	Responsibilities
Scenario deviser	<ul style="list-style-type: none"> • Detailing the scenario • Suggesting unpredicted events and unforeseen situations
Planner	<ul style="list-style-type: none"> • Devising the plan
Participant	<ul style="list-style-type: none"> • Monitoring the scenario • Applying the plan • Diagnosing unforeseen situations (identification and interpretation)

Roles	Responsibilities
Researcher	<ul style="list-style-type: none"> • Conducting and observing the experiment • Collecting data for later analysis • Removing doubts
Technical specialist	<ul style="list-style-type: none"> • Providing technical information for running the experiment

Two experiments were conducted: one experiment at Secretaria Municipal de Defesa Civil de Niterói on 11/Nov/2016 and another at Mestrado em Defesa e Segurança Civil on 25/Nov/2016. Both experiments followed the steps shown in Figure 6-5. Experiment started with a brief introduction. Researchers presented an overview of the thesis, introducing the tool that supported the experiment. They explained that the tool enables the visualization of the previously developed plan for handling the ongoing scenario and the current conditions of the scenario handling. Participants should use this tool to support the decision-making during the scenario handling. Researchers also detailed the initial context of the scenario handled and what was expected with the emergency handling.

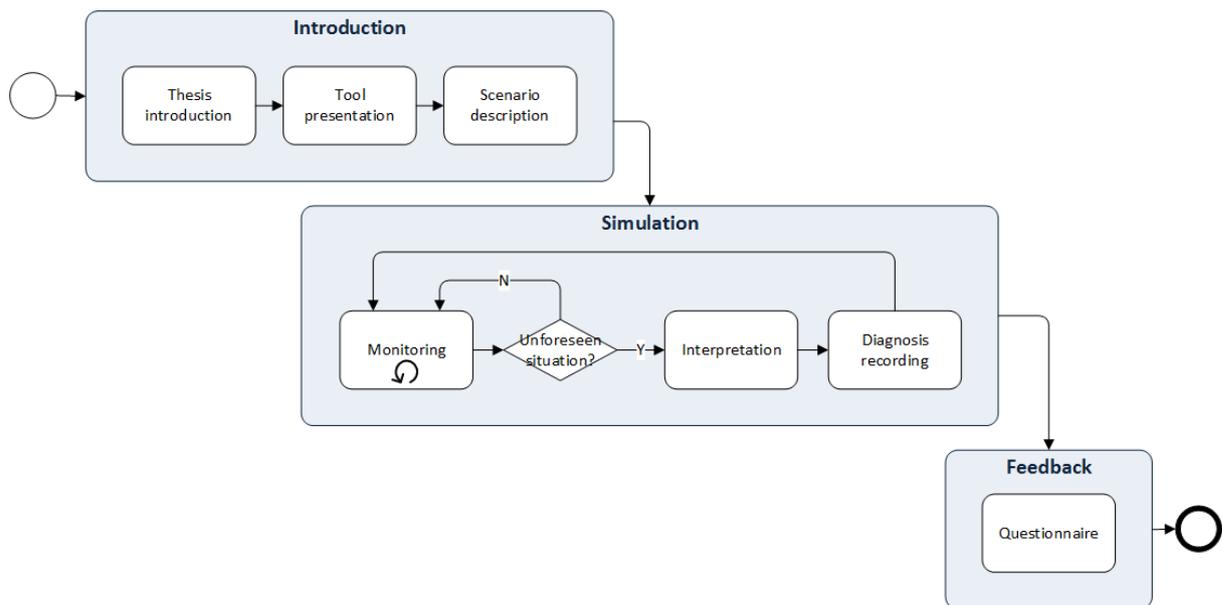


Figure 6-5: Experiment steps

After this brief introduction, the simulation began, meaning that participants started monitoring the scenario handling. For this, participants had access to a step by step situation, so they were aware of the current conditions of the scenario handling (observed situation). With this information, participants decided how to apply the existing plan for handling the scenario observed situation and assessed the plan adequacy for its purpose.

During the simulation, the unforeseen situations, which were defined by the scenario deviser (Appendix 3), were proposed. These situations occurred at specific moments that were pre-determined during the scenario devising. For instance, the scenario deviser defined that a specific unforeseen situation should occur 30 seconds after the beginning of the simulation or that another unforeseen situation should occur after the execution of the “Action 3” described in the plan. Participants were responsible for identifying the proposed event and unforeseen situation arising from it, and diagnosing if these situations required or not a plan adaptation.

The tool performed a comparison between the selected plan, situation awareness and predefined parameters to assess the adequacy of this plan to the reality faced. If any inconsistency was identified, perception mechanisms evidenced it. When participants clicked on these mechanisms, the tool showed details of the unforeseen situation, allowing participants to analyze/interpret this situation. As a result of the interpretation, participants provided a diagnostic of the unforeseen situation, comprising (a) the unforeseen situation faced; (b) if this unforeseen situation has led or not to a plan disruption; and (c) if so, what should be done to solve the disruption. For the latter item, in some cases, the unforeseen situation could be easily solved by the elements present in the existing plan. I.e. the situation was evolving to a different pattern from the one defined at that point of the plan, but actions that allow handling this different evolution were described at a later point of the plan. Thus, participants might decide to move to the appropriate point of the plan. However, in other cases, a solution to the problem was not so trivial. When the plan did not establish actions for handling the scenario evolution, participants had to adapt the plan. Participants might apply an existing and evaluated plan to provide a solution for the faced disruption or, when the prior formal knowledge fail to provide a solution for the disruption, participants should improvise actions. Plan adaptation is beyond the scope of the planned experiment, and it will be evaluated through a future experiment.

The experiment would end after the last predefined unforeseen situation was proposed or 60 minutes after the beginning of the simulation.

6.4 Data analysis

The proposed approach evaluation was made through the identification of data gathered from the experiment that would allow answering the research questions and assess

the applicability of the approach for on-the-fly adaptation of plans in unforeseen situations. This data was gathered from recordings made by researchers during the experiment. Complementing the recordings, the system logs and any extra documentation (reports and notes) produced by the participants were also retrieved. Besides that, a questionnaire was answered (Appendix 4), thus helping to identify participants' perceptions about the benefits and limitations of the approach. The obtained results were summarized and presented to the participants so that they could have a feedback about the benefits and limitations of the ideas proposed in the approach.

The following subsections detail the analysis, based on data obtained from the experiments, to answer the research questions.

6.4.1 First experiment: Civil Defense of Niterói

The experiment was conducted at Secretaria Municipal de Defesa Civil de Niterói on 11/Nov/2016. This secretariat is responsible for applying similar procedures to the selected contingency plan and counts on professionals who constantly deal with the adopted scenario. This experiment lasted 1h30 and had 3 participants.

6.4.1.1 Team profile

The response team was formed by these 3 professionals from Secretaria Municipal de Defesa Civil de Niterói. All of them had some relation with the adopted scenario, such as acting in training communities to minimize disasters, conducting a preventive and reactive analysis of areas with landslide risk, and performing meteorological monitoring. They also had different levels of experience in this scenario (Figure 6-6).

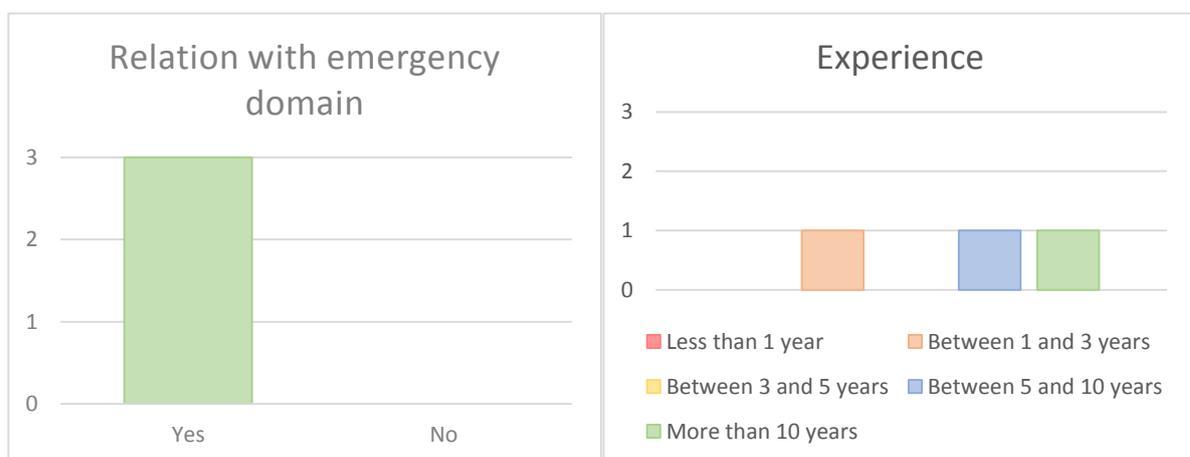


Figure 6-6: Response team profile

Thus, despite being a small group, it is argued that this team adequately represents the structure and required roles for a response team in control room while handling the emergency described in the scenario. They often deal with high-pressure events, being able to handle a scenario describing a 1h event whose actual duration was about 8h.

6.4.1.2 How the decision support mechanisms affect the team performance during the identification of unforeseen situations, considering the task difficulty?

Goal: Assessing how the decision support mechanisms, in terms of plan presentation and detailing, and mechanisms adopted to indicate plan problems, affect the team performance during the identification of unforeseen situations.

During the experiment, 5 unforeseen situations planned by the scenario deviser (45.45%) were proposed. The other 6 unforeseen situations were not proposed because the experiment reached the planned 1h duration. The percentage of identified unforeseen situations was 100%, with all proposed unforeseen situations being identified by participants. I.e., participants analyzed the 5 proposed unforeseen situations.

The average detection duration was almost immediately. As soon as an unforeseen situation was proposed, participants identified it as a problem to be solved.

In this group, the discrepancy degree for unforeseen situation analysis was 0, meaning that any difference between the expected and observed values of the state variables demanded further analysis.

Besides the system log analysis, the questionnaire provided extra information about participants' perception about the identification of unforeseen situations. Regarding the plan presentation through the proposed elements (Figure 6-7), the participants had a positive opinion about the plan presentation through a flow (2 participants agree and 1 partially agrees with such statement). 2 participants agree and 1 partially agrees that the plan presentation through the proposed elements facilitates actions understanding. 2 participants also agree that this representation facilitates actions monitoring, but the most experienced participant partially disagrees with it. He reported that *"The sequence is interesting. However, the presented scenario is characteristic and particular"*. 2 participants also had a neutral perception and 1 partially agrees about the plan presentation through the proposed elements to be less confusing than other plan presentations. All participants partially agree that they had difficulties to understand the plan presentation.

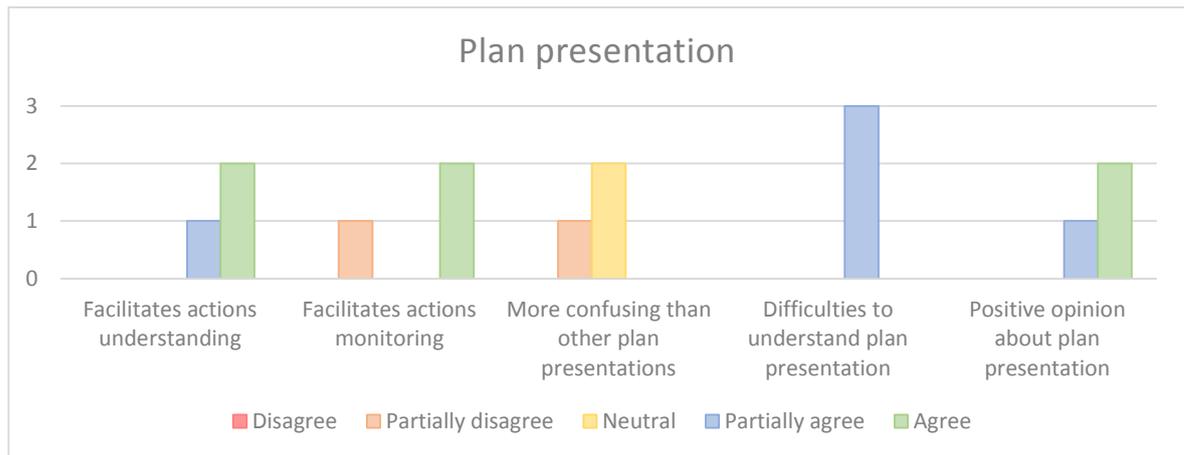


Figure 6-7: Participants' answers on plan presentation through proposed elements

Also regarding the plan presentation through the proposed elements, but now focusing on extra information about actions being performed (Figure 6-8), the participants had a positive opinion on it (2 participants agree and 1 partially agrees with this statement). They all agree that this information is relevant to understand the action being performed, and 2 participants partially agree that this information is relevant to understand the current situation of emergency response. 2 participants also disagree that this information is excessive to understand the action being performed and the current situation of emergency response, but the most experienced participant partially agrees with an excess of information to understand the action being performed and the current situation of emergency response. Participants also had a neutral perception or partially agree on tool not providing all the required information for understanding the action being performed (1 and 2, respectively) and the current situation of emergency response (2 and 1, respectively). The difficulty of understanding the plan was more distributed than the previous question, with participants agreeing, partially agreeing or disagreeing with this statement. Both participants with more and less experience in the field reported this difficulty (agree or partially agree, respectively).

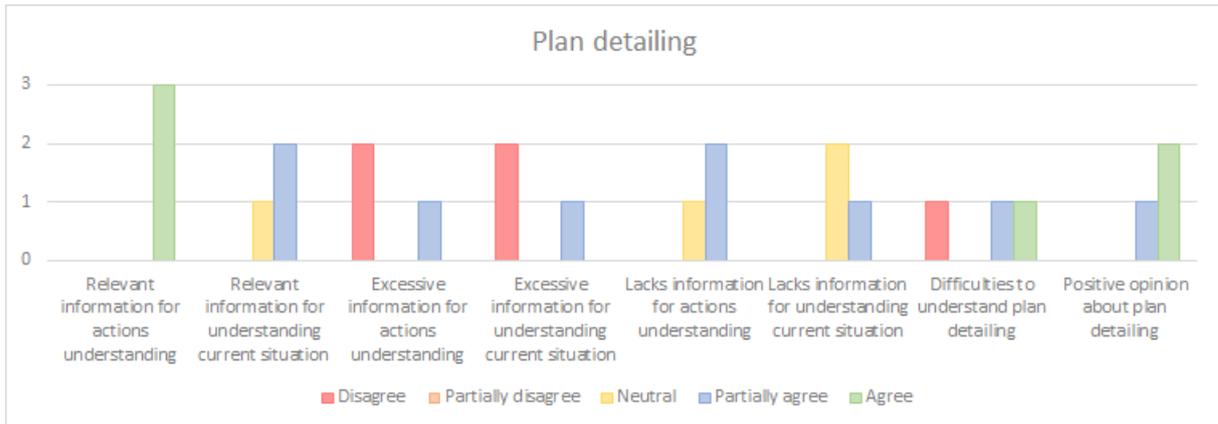


Figure 6-8: Participants’ answers on extra information about actions

Regarding the perception mechanisms for indicating plan problems (Figure 6-9), all participants had a positive opinion on it (they all agree with this statement). 2 participants agree and 1 partially agrees that these mechanisms reduce the required time to identify problems, and all participants agree that these mechanisms help to identify what were the problem causes. The most experienced participant considered that the mechanism for indicating plan problems was not so clear and difficult to understand. However, he points out that *“All provided information is necessary for decision making”*.

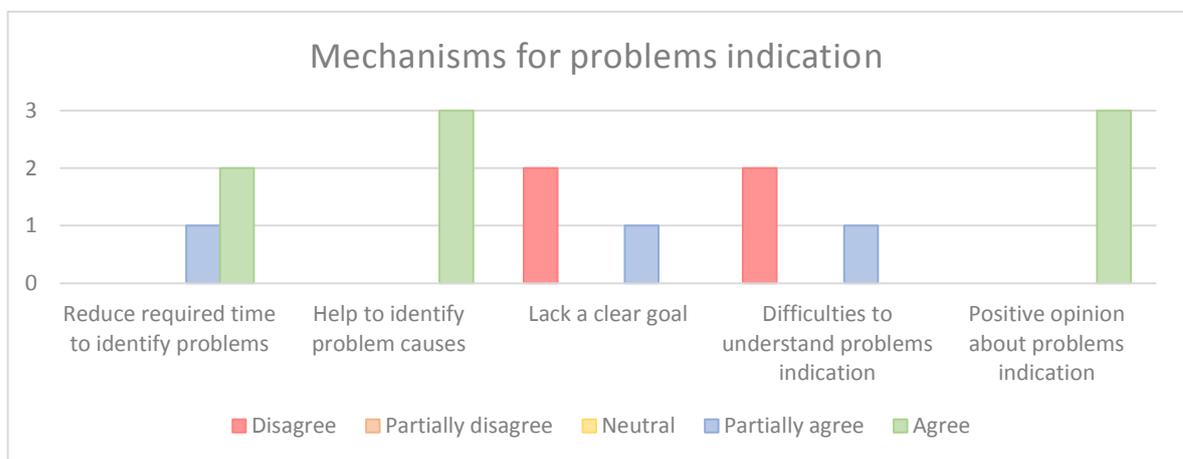


Figure 6-9: Participants’ answers on mechanisms for indicating plan problems

6.4.1.3 How the decision support mechanisms affect the team performance during the interpretation of unforeseen situations, considering the task difficulty?

Goal: Assessing how the decision support mechanisms, in terms of information for unforeseen situation analysis and characterization, mechanisms for indicating inconsistencies, information for solutions generation, affect the team performance during the interpretation of unforeseen situations.

During the experiment, the average diagnosis duration was 05:39 minutes (Table 6-4). Easy tasks took 03:54 minutes, medium tasks took 08:10 minutes and hard tasks took 08:23 minutes.

Table 6-4: Unforeseen situation average diagnosis duration

Unforeseen situation	Task difficulty	Identification time	Solution time	Diagnosis duration
1	Easy	11:28:53	11:34:39	00:05:46
2	Medium	11:43:11	11:51:21	00:08:10
3	Hard	11:51:29	11:59:52	00:08:23
4	Easy	12:07:21	12:08:10	00:00:49
5	Easy	12:10:33	12:15:41	00:05:08
Average diagnosis duration				00:05:39

For this group, the expected result of the comprehensive analysis of all proposed unforeseen situation and the result established by the participants were the same. I.e. participants judged that all unforeseen situations required further analysis.

Participants also provided 10 solutions, with more than 1 solution for each disruption identified (Table 6-5). The proximity factor between solution and disruption was 100%, with all proposed solutions content being related to the identified disruption. There was no disruption without a relevant solution for it.

Table 6-5: Solutions for unforeseen situations

Unforeseen situation	Task difficulty	Unforeseen situation description	Solution
1	Easy	Alarm is not working	Field agents perform a manual activation if necessary
			Warning community volunteers about the strong rainfall and, if necessary, lead community to safe areas and/or friends' house
			Calling later
2	Medium	No coordinator authorization	Trying to contact another person, considering the authorization scale
			If I couldn't reach any person, I would take the personal initiative to send the message
3	Hard	No contact with leader	Sending team to the affected community
			Warning on loudspeakers
			Send message to NUDEC group on WhatsApp when finding a Strong rainfall is coming
4	Easy	No contact	Same solution as provided before
5	Easy	No contact	Agent has already been notified to go to the affected community

Besides the system log analysis, the questionnaire provided extra information about participants' perception about the interpretation of unforeseen situations. Regarding the information for unforeseen situation analysis and characterization (Figure 6-10), all participants had a positive opinion about this information (they partially agree with this statement). 1 participant agrees and 2 partially agree that the information for unforeseen situation analysis and characterization facilitates the understanding of the current situation of emergency response, but all participants partially agree that information does not provide enough inputs for the unforeseen situation analysis. The most experienced participant had difficulty with such information. However, he points out that the information provides a *“need for plan review and adjustment”*.

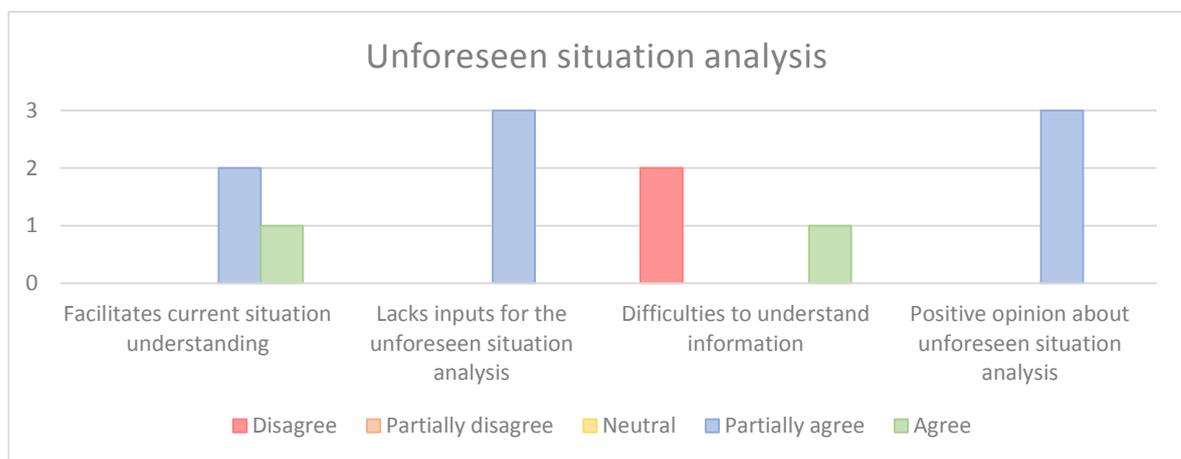


Figure 6-10: Participants' answers on information for unforeseen situation analysis

Regarding the perception mechanisms for indicating variable inconsistencies (Figure 6-11), all participants had a positive opinion on it (they all agree with this statement). They all agree that these mechanisms facilitate the plan problems analysis; 2 participants agree and 1 partially agrees that these mechanisms reduce the required time for identifying problems; and 2 participants agree and 1 partially agrees that these mechanisms help to identify what were the problem causes. The most experienced participant considered that the mechanism for indicating variables inconsistencies was not so clear and all participants had difficulties to understand such mechanism. One of the participants points out that *“The images (pictures) were small. It would be better with greater prominence”*.

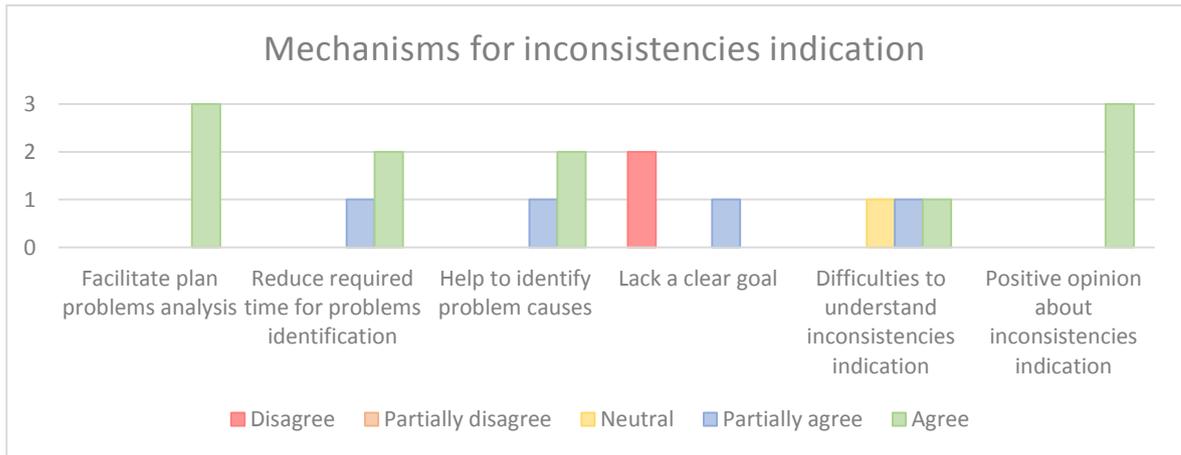


Figure 6-11: Participants’ answers on mechanisms for indicating variable inconsistencies

Regarding the information for providing solutions to the identified problems (Figure 6-12), the participants had a positive opinion on it (2 participants agree and 1 partially agrees). 1 participants agree and 1 partially agree that the information for providing solutions to the identified problems provides sufficient inputs for plan adaptation, but 1 disagrees with this statement. He points out that there were *“solutions repetitions at different stages”*. 2 participants also disagree and 1 is neutral about whether this information is excessive for the plan adaptation. The most experienced participant considered difficult to understand the solutions provision. He points out that *“Information always adds up. The greater difficulty may be the rigidity that system generates”*.

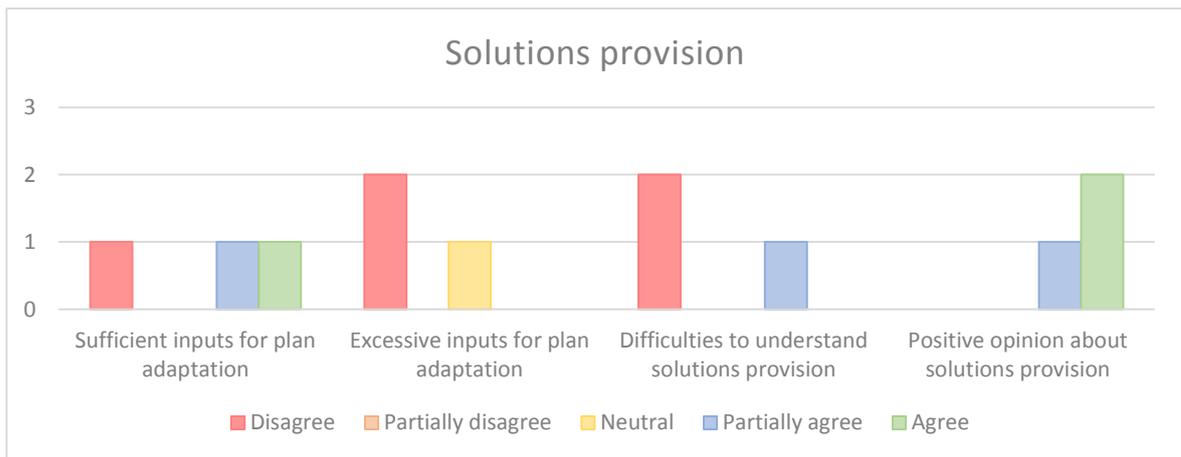


Figure 6-12: Participants’ answers on information for providing solutions to identified problems

6.4.2 Second experiment: Mestrado em Defesa e Segurança Civil/UFF

The experiment was conducted at Mestrado em Defesa e Segurança Civil on 25/Nov/2016. This graduate program of Universidade Federal Fluminense (UFF) aims to train

human resources to meet Brasil's needs in policies elaboration, planning and actions in Defense and Civil Security throughout the national territory. This experiment lasted 1h and had 9 participants.

6.4.2.1 Team profile

Participants were divided into two response teams. The first response team was formed by 3 graduate program students and 1 graduate program professor. 3 participants had some relation with the emergency domain, such as acting in the regional department of Civil Defense, coordinating the regional school of Civil Defense and devising plans for the nuclear center, and 1 participant reported that had no relation with this domain, besides being a member of the graduate program. 3 participants had more than 10 years of experience in this domain and 1 participant did not answer this question (Figure 6-13).

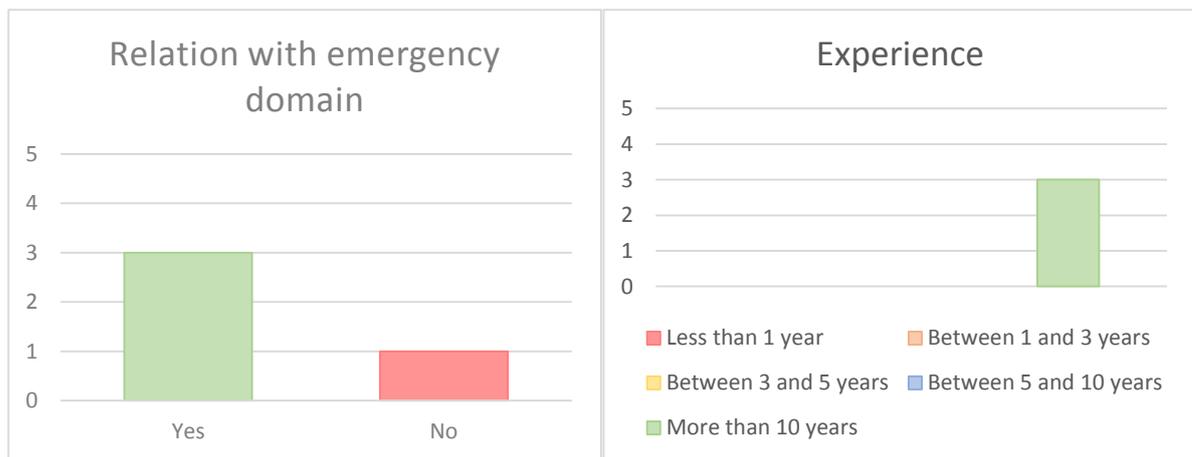


Figure 6-13: First response team's profile

The second response team was formed by 5 graduate program students. 3 participants had some relation with the emergency domain, such as acting in the regional department of Civil Defense, managing crisis and devising plans for hydroelectric dams, and 2 participants reported that had no relation with this domain, besides being a member of the graduate program. 3 participants had more than 5 years of experience in this domain (1 participant had 10 years of experience and 2 participants had 5 to 10 years of experience) and 2 participants did not answer this question (Figure 6-14).

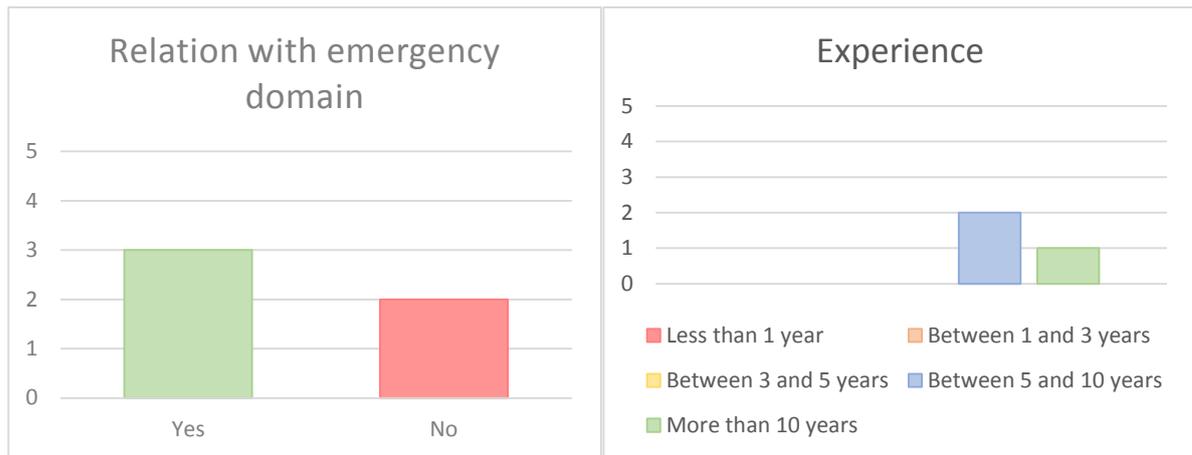


Figure 6-14: Second response team's profile

Thus, despite being a small group, it is argued that both teams adequately represent the structure and required roles for a response team in control room while handling the emergency described in the scenario. Participants had many years of experience in this domain, often dealing with high-pressure events.

6.4.2.2 How the decision support mechanisms affect the team performance during the identification of unforeseen situations, considering the task difficulty?

During the experiment, 4 unforeseen situations planned by the scenario deviser (36.36%) were proposed to the first response team and 2 unforeseen situations (18.18%) were proposed to the second response team. The other unforeseen situations were not proposed because the experiment reached the available time (40 minutes). The percentage of identified unforeseen situations was 100% for both response teams, with all proposed unforeseen situations being identified by participants.

The average detection duration was almost immediately for both response teams. As soon as an unforeseen situation was proposed, participants identified it as a problem to be solved.

In this group, the discrepancy degree for unforeseen situation analysis was 0, meaning that any difference between the expected and observed values of the state variables demanded further analysis.

Besides the system log analysis, the questionnaire provided extra information about participants' perception about the identification of unforeseen situations. Regarding the plan presentation through the proposed elements, the participants of the first response team had a positive opinion about the plan presentation through a flow (1 participant agrees and 2

partially agree with this statement) (Figure 6-15). 1 participant agrees and 2 partially agree that the plan presentation through the proposed elements facilitates actions understanding, but 1 participant partially disagrees with it. 2 participants also agree and 1 partially agrees that this representation facilitates actions monitoring, but 1 participant disagrees with it. The opinion about the proposed presentation being more confusing than other plan presentation was more distributed, with a participant partially agreeing with it. Participants agree, partially agree or are neutral about having difficulties to understand the plan presentation. The participant with more criticisms about the plan presentation highlighted the main problems in its opinion: *“Plan letter is small”*, *“The tool does not allow to correct or to add addition information to answers”* and *“The plan should present icons for actions to be taken in each situation”*.

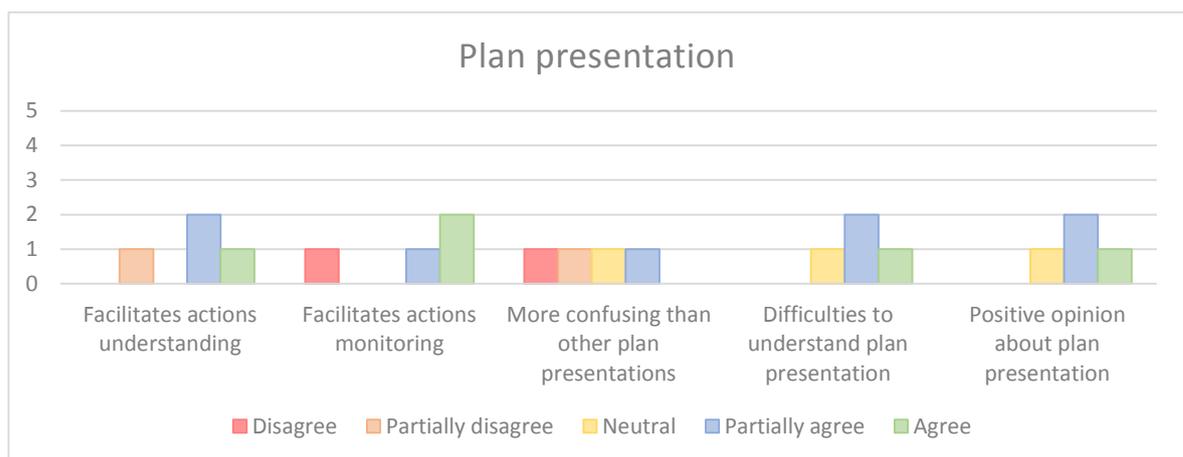


Figure 6-15: First response team’s answers on plan presentation through proposed elements

Participants of the second response team had a positive opinion about the plan presentation through a flow (2 participants agree and 3 partially agree with this statement) (Figure 6-16). 1 participant agrees and 3 partially agree that the plan presentation through the proposed elements facilitates actions understanding. 2 participants also agree and 2 partially agree that this representation facilitates actions monitoring. 4 participants had a neutral perception and 1 partially disagrees about the plan presentation through the proposed elements to be less confusing than other plan presentations. 3 participants partially disagree and 1 participant is neutral about having difficulties to understand the plan presentation, but 1 participant agrees with it. Participants pointed out that *“the interface needs to be more user-friendly and intuitive to further explore the possibilities that the plan offers”* and *“interface is confused”*. However, they also highlighted the benefits of the proposed plan presentation: *“It*

helps identify possible plan changes and standardize possible solutions that may become the standard operating procedure in the future” and “The aspect regarding the graphical presentation of the plan was positive”.

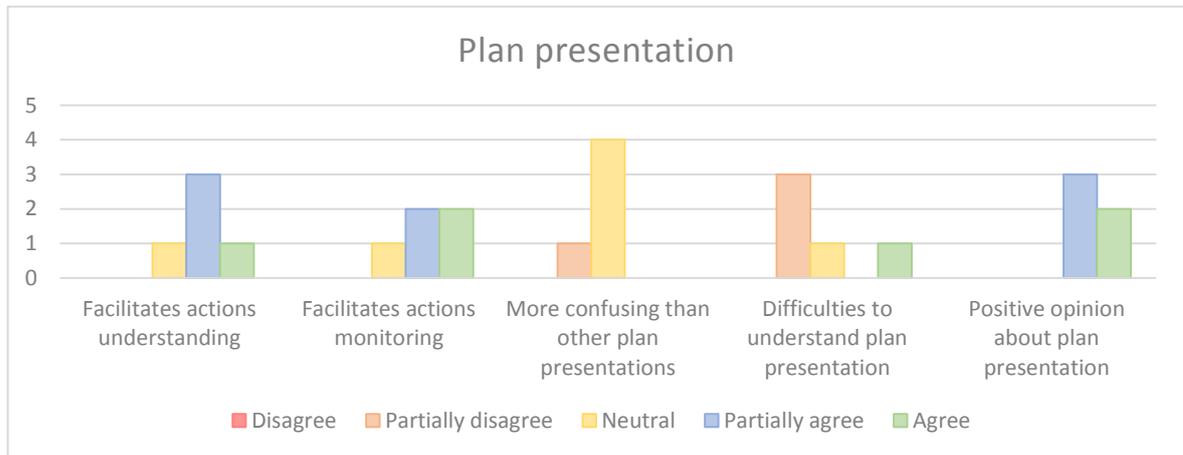


Figure 6-16: Second response team’s answers on plan presentation through proposed elements

Also regarding the plan presentation through the proposed elements, but now focusing on extra information about actions being performed, the participants of the first response team’s opinion on it were more distributed, with 1 participant partially disagreeing with this statement (Figure 6-17). 3 participants partially agree that this information is relevant to understand the action being performed and the current situation of emergency response, but 1 participant partially disagrees with such statements. He reported that *“it is still a tool that presents the obstacles, but not the ways to the solution”*. Participants disagree that this information is excessive to understand the action being performed (3 participants partially disagree) and the current situation of emergency response (2 participants disagree and 2 partially disagree). Participants also agree on tool not providing all the required information for understanding the action being performed (3 participants agree) and the current situation of emergency response (2 participants agree and 2 partially agree). 3 participants agree about having difficulties to understand the plan detailing.

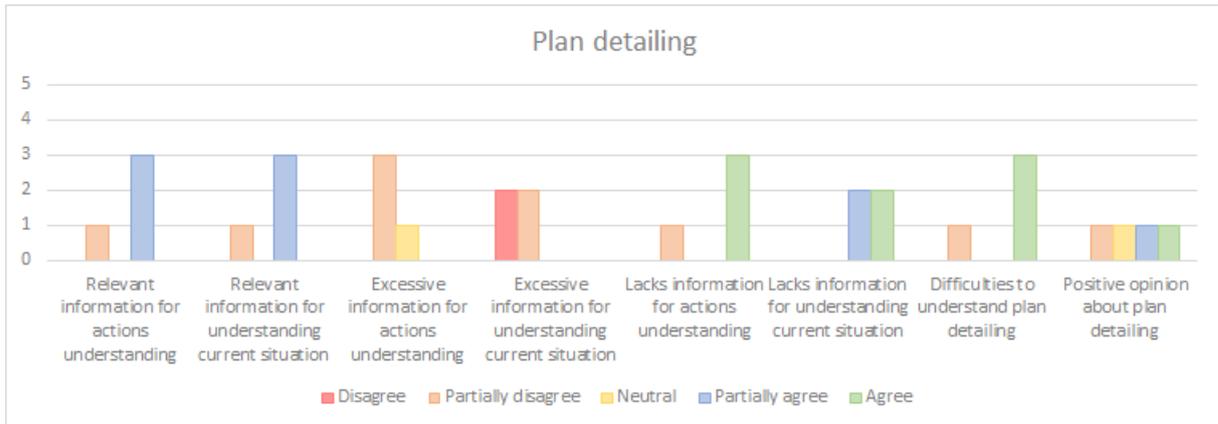


Figure 6-17: First response team’s answers on extra information about actions

Participants of the second response team had a positive opinion on it (3 participants agree and 2 partially agree with this statement) (Figure 6-18). They agree that this information is relevant to understand the action being performed (2 participants agree and 3 partially agree) and the current situation of emergency response (1 participant agrees and 3 partially agree). Participants disagree that this information is excessive to understand the action being performed and the current situation of emergency response. Most of the participants also disagree on tool not providing all the required information for understanding the action being performed and the current situation of emergency response (4 and 3 participants, respectively), but 2 participants agree with such statements. One of them reported that is necessary to *“improve the interface”*, with a different participant suggesting *“screens could be better exploited as windows, not requiring to close one screen to open another one”*. The difficulty to understand the plan detailing was smaller than in the first response team, with 2 participants agreeing with it.

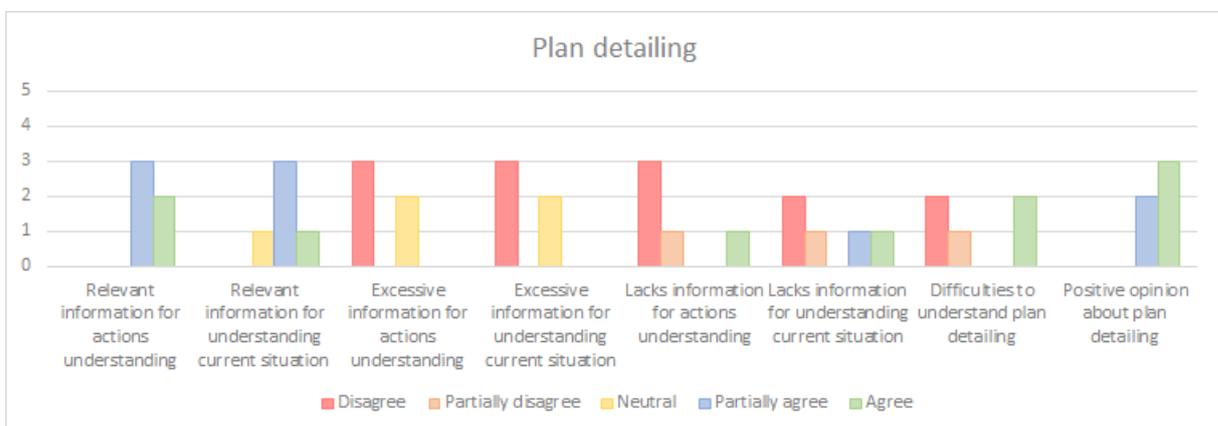


Figure 6-18: Second response team’s answers on extra information about actions

Regarding the perception mechanisms for indicating plan problems, the participants of the first response team had a positive opinion on it (3 participants agree and 1 partially agrees with this statement) (Figure 6-19). 2 participants partially agree that these mechanisms reduce the required time to identify problems, but 2 participants partially disagree with such statement. One of them reported that *“each problem must present a range of possible solutions”*. 2 participants agree and 1 partially agrees that these mechanisms help to identify what were the problem causes, but the participant who did not have practical experience with Civil Defense partially disagree with such statement. 2 participants considered that the mechanism for indicating plan problems was not so clear, which included the participant who did not have practical experience with Civil Defense. 3 participants partially agree about having difficulties to understand problems indication.

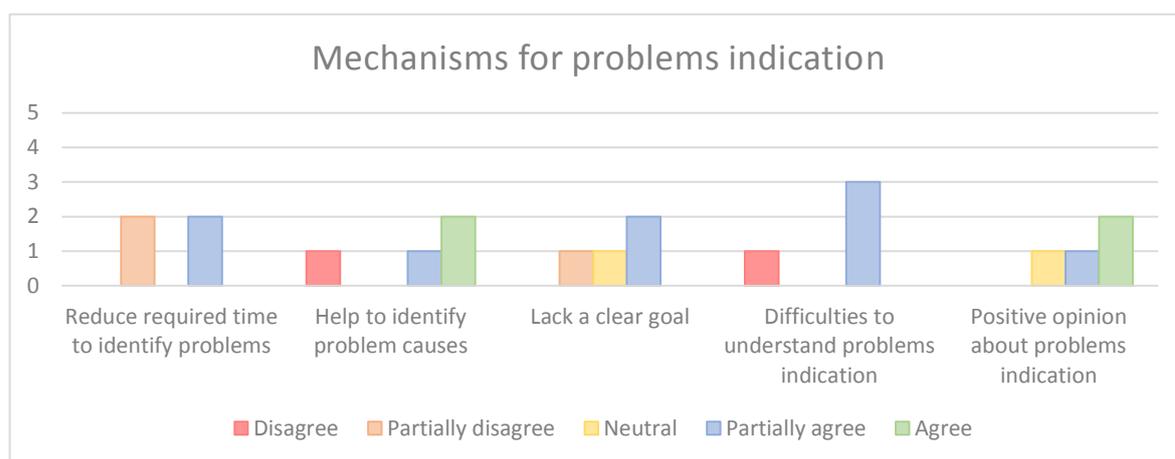


Figure 6-19: First response team’s answers on mechanisms for indicating plan problems

The participants of the second response team had a positive opinion on it (3 participants agree and 2 partially agree with this statement) (Figure 6-20). All participants agree that these mechanisms reduce the required time to identify problems, and 3 participants agree and 2 partially agree that these mechanisms help to identify what were the problem causes. All participants disagree that the mechanism for indicating plan problems was not so clear and did not report difficulties to understand problems indication (3 disagree and 1 partially disagrees on it). Participants pointed out *“combined with the knowledge of those who monitor the plan, the information acquired generates possible actions to be adapted”* and *“the mechanisms help to visualize problems that must be overcome by the crisis team”*.

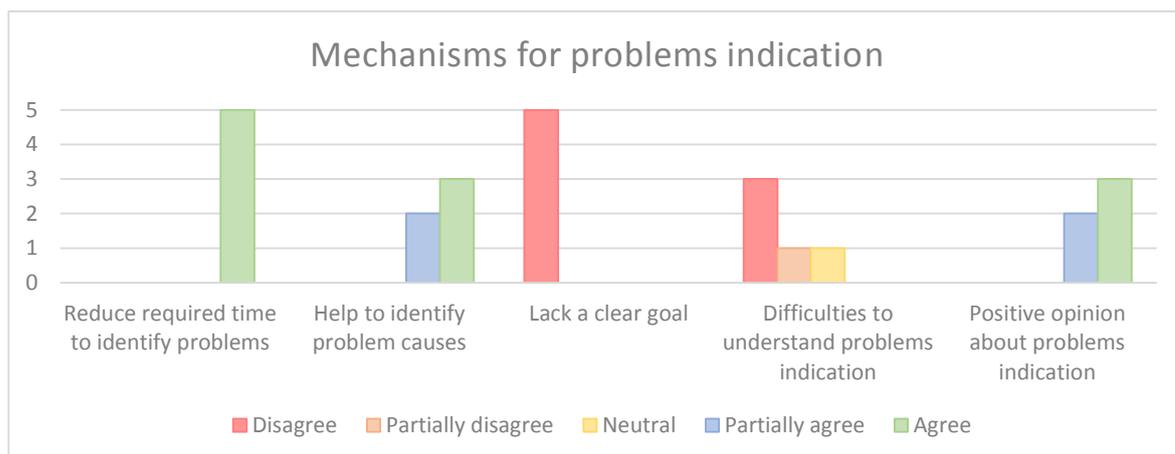


Figure 6-20: Second response team's answers on mechanisms for indicating plan problems

6.4.2.3 How the decision support mechanisms affect the team performance during the interpretation of unforeseen situations, considering the task difficulty?

The average diagnosis duration was 03:46 minutes for the first response team (Table 6-6). Easy tasks took 04:16 minutes, medium tasks took 02:26 minutes and hard tasks took 04:16 minutes.

Table 6-6: Unforeseen situation average diagnosis duration for the first response team

Unforeseen situation	Task difficulty	Identification time	Solution time	Diagnosis duration
1	Easy	17:45:01	17:50:15	00:05:14
2	Medium	17:53:54	17:56:20	00:02:26
3	Hard	17:57:59	18:02:15	00:04:16
4	Easy	18:03:10	18:06:20	00:03:10
Average diagnosis duration				00:03:46

For the second response team, the average diagnosis duration was 16:57 minutes (Table 6-7). It is higher than in the other groups because participants discussed a lot about both faced unforeseen situations and the benefits and limitations of the proposed approach and the tool, before recording their final decision into the tool.

Table 6-7: Unforeseen situation average diagnosis duration for the second response team

Unforeseen situation	Task difficulty	Identification time	Solution time	Diagnosis duration
1	Easy	17:32:40	17:53:11	00:20:31
2	Medium	17:53:44	18:07:07	00:13:23
Average diagnosis duration				00:16:57

The expected result of the comprehensive analysis of all proposed unforeseen situation and the result established by the participants were the same for both response teams. I.e. participants judged that all unforeseen situations required further analysis.

Participants of the first response team provided 15 solutions, with more than 1 solution for each disruption identified (Table 6-8). The proximity factor between solution and disruption was 100%, with all proposed solutions content being related to the identified disruption. There was no disruption without a relevant solution for it.

Table 6-8: First response team's solutions for unforeseen situations

Unforeseen situation	Task difficulty	Unforeseen situation description	Solution
1	Easy	Alarm offline	Call responsible for alarm
			Send agents for manual activation
			Mobilize community agents
			Mobilize NUDEC
			Send messages (SMS or WHATS APP)
2	Medium	No contact using SMS	Use amateur radio
			Use cars with sound systems
			Use popular and community radio stations
			Mobilize community agents
3	Hard	Outdated contact	Find updated telephone number (institutional website, friends etc.)
			Find required resources in other institutions
4	Easy	Heavy rains in some regions	Open safety areas
			Activate alarms
			Coordinate the evacuation of affected areas through Civil Defense agents and community agents
			Alert other agencies (Health system, Schools, Transportation etc.)

Participants of the second response team provided 3 solutions, with more than 1 solution for each disruption identified (Table 6-9). The proximity factor between solution and disruption was 100%, with all proposed solutions content being related to the identified disruption. There was no disruption without a relevant solution for it.

Table 6-9: Second response team's solutions for unforeseen situations

Unforeseen situation	Task difficulty	Unforeseen situation description	Solution
1	Easy	No contact with responsible for off-line alarms	Send team to central responsible for alarm maintenance
			Request field support
2	Medium	Unable to send SMS	Assess the possibility to contact the CRAS (Centro de Referência em Assistência Social)

Besides the system log analysis, the questionnaire provided extra information about participants' perception about the interpretation of unforeseen situations. Regarding the information for unforeseen situation analysis and characterization, the participants of the first response team had a positive opinion about this information (2 participants agree and 1 partially agrees with this statement) (Figure 6-21). 2 participants agree and 2 partially agree that the information for unforeseen situation analysis and characterization facilitates the understanding of the current situation of emergency response, but participants' majority agree that information does not provide enough inputs for the unforeseen situation analysis (2 participants agree and 1 partially agrees). Participants also had difficulty with such information.

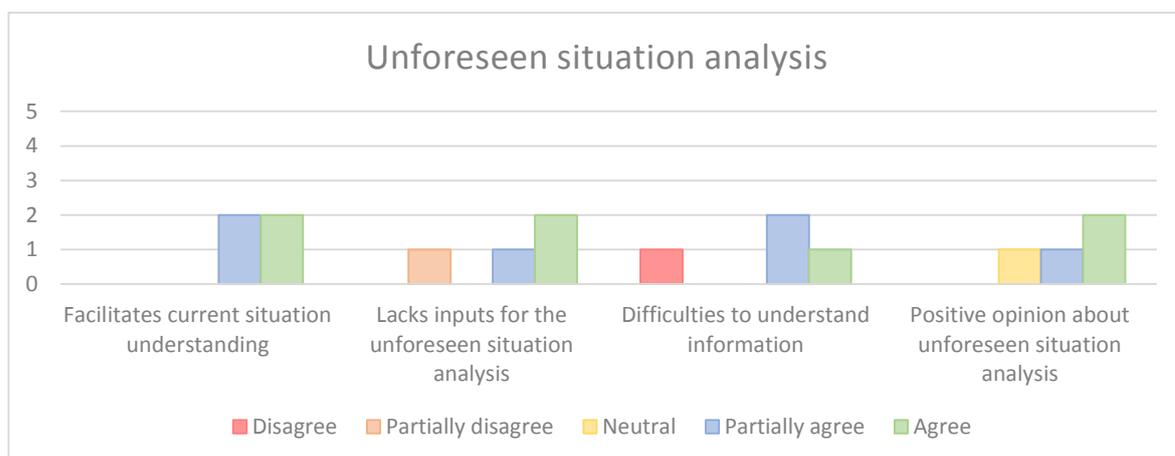


Figure 6-21: First response team's answers on information for unforeseen situation analysis

Participants of the second response team had a positive opinion about this information (3 participants agree and 2 partially agree with this statement) (Figure 6-22). 3 participants agree and 2 partially agree that the information for unforeseen situation analysis and characterization facilitates the understanding of the current situation of emergency response. Participants disagree that information does not provide enough inputs for the unforeseen situation analysis (1 participant disagrees and 3 partially disagree), but 1 participant partially

agrees with it. The difficulty of understanding the information for unforeseen situation analysis was more distributed than in the first response team, but with 2 participants partially agreeing with this statement. However, participants also reinforced that *“mechanisms help to visualize the problems that must be overcome by the crisis team”*.

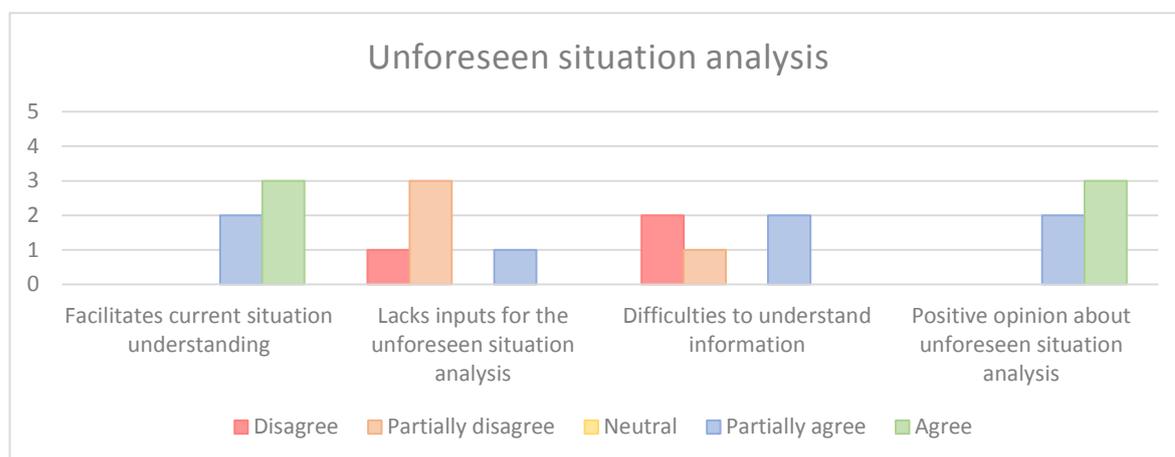


Figure 6-22: Second response team’s answers on information for unforeseen situation analysis

Regarding the perception mechanisms for indicating variable inconsistencies, participants of the first response team had a positive opinion on it (2 participants agree and 2 partially agree with this statement) (Figure 6-23). 2 participants partially agree that these mechanisms facilitate the plan problems analysis, but 1 participant disagrees with it. He reported that it is still necessary *“more clear tools”*. The opinion about the mechanisms for indicating variables inconsistencies help to reduce the required time for identifying problems was more distributed, with 1 participant partially disagreeing with it. He reported that it is still necessary *“more clear tools”*. However, 2 participants agree and 1 partially agrees that these mechanisms help to identify what were the problem causes and participants disagrees that these mechanisms lack a clear goal. Participants also reported difficulties to understand such mechanisms.

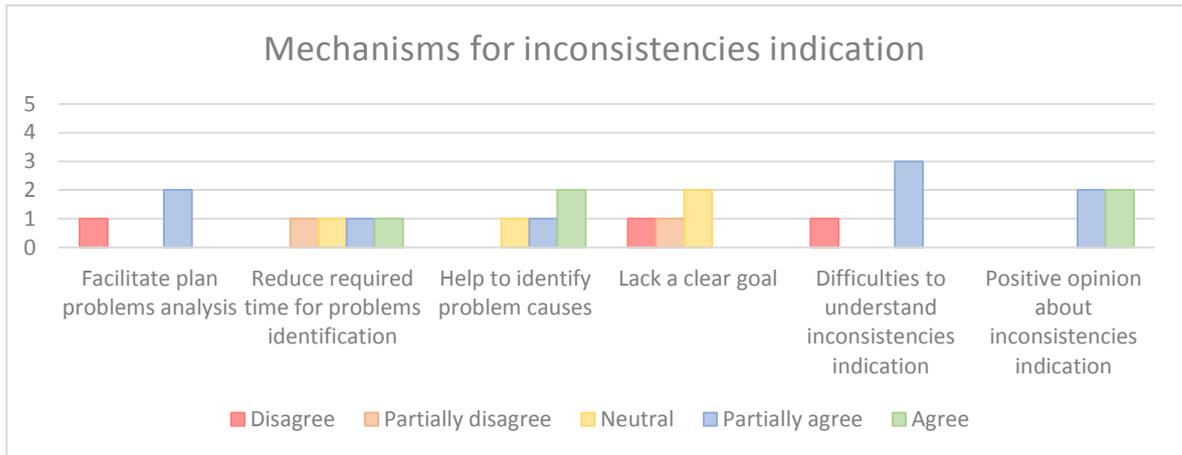


Figure 6-23: First response team’s answers on mechanisms for indicating variable inconsistencies

The participants of the second response team’s opinion on mechanisms for indicating variables inconsistencies was more distributed, with 2 participants partially disagreeing with this statement (Figure 6-24). 2 participants agree and 2 partially agree that these mechanisms facilitate the plan problems analysis; 2 participants agree and 2 partially agree that these mechanisms reduce the required time for identifying problems; and 2 participants agree and 1 partially agrees that these mechanisms help to identify what were the problem causes. However, 1 participant partially disagrees with mechanisms helping to identify problem causes. He reported that *“visualization needs improvements. It is necessary to provide more suggestions on solving problems”*. Participants disagrees that these mechanisms lack a clear goal and did not have difficulties to understand such mechanism. One of the participants pointed out that *“presenting the variables inconsistencies on screen helps to be aware of the problem”*.

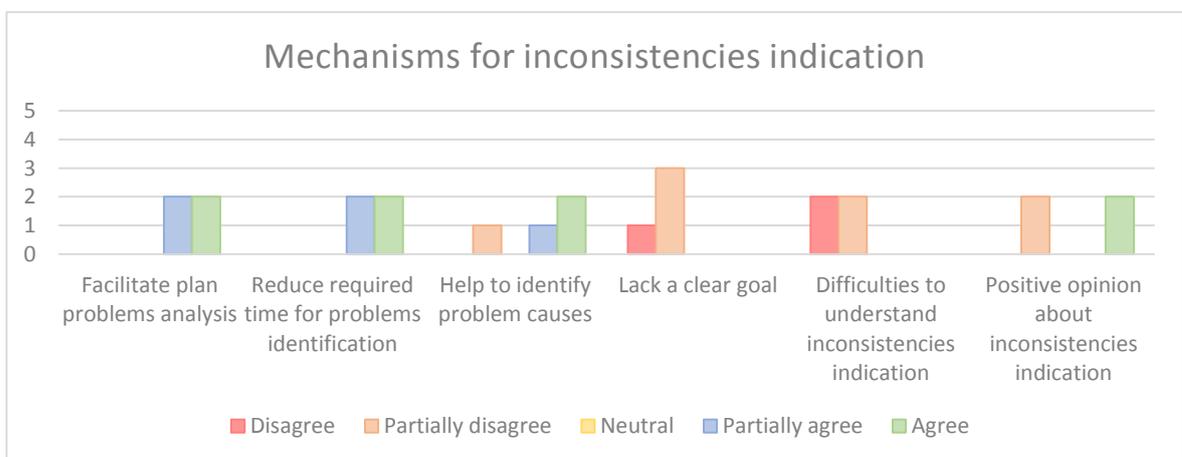


Figure 6-24: Second response team’s answers on mechanisms for indicating variable inconsistencies

Regarding the information for providing solutions to the identified problems, the participants of the first response team's opinion was also distributed, with participants agreeing, partially agreeing, disagreeing and having neutral opinion on this statement (Figure 6-25). Participants were divided about the information for providing solutions to the identified problems providing sufficient inputs for plan adaptation. One participant that partially disagrees reported that it is still necessary *"more clear tools"* and the other one was one of the participants who did not have practical experience in Civil Defense. 3 participants also disagree and 1 partially disagrees about whether this information is excessive for the plan adaptation. Participants considered difficult to understand the solutions provision. They pointed out that the tool needs *"to be flexible to introduce situations during the plan execution"* and *"to allow participants feedback with information"*.

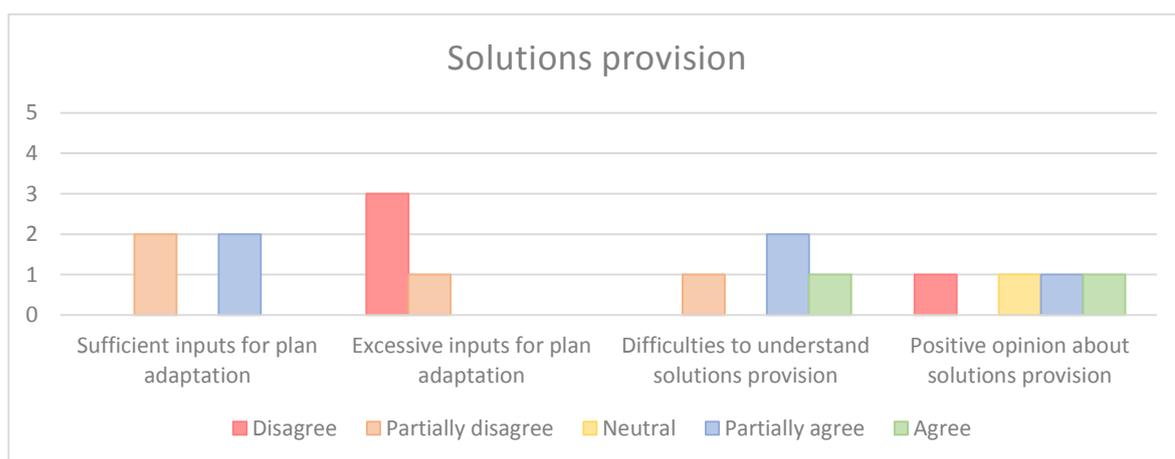


Figure 6-25: First response team's answers on information for providing solutions to identified problems

Participants of the second response team had a positive opinion on it (2 participants agree and 2 partially agree) (Figure 6-26). 1 participant agrees and 4 partially agree that the information for providing solutions to the identified problems provides sufficient inputs for plan adaptation. Participants also disagree whether this information is excessive for the plan adaptation. Participants did not consider difficult to understand the solutions provision, but one of the participants that did not have experience in the emergency domain considered difficult to understand the solutions provision. One participant reported that *"the possibility of recording the solutions adopted in the crisis helps in decision-making for future crises by providing inputs for learning from the experience gained"*.

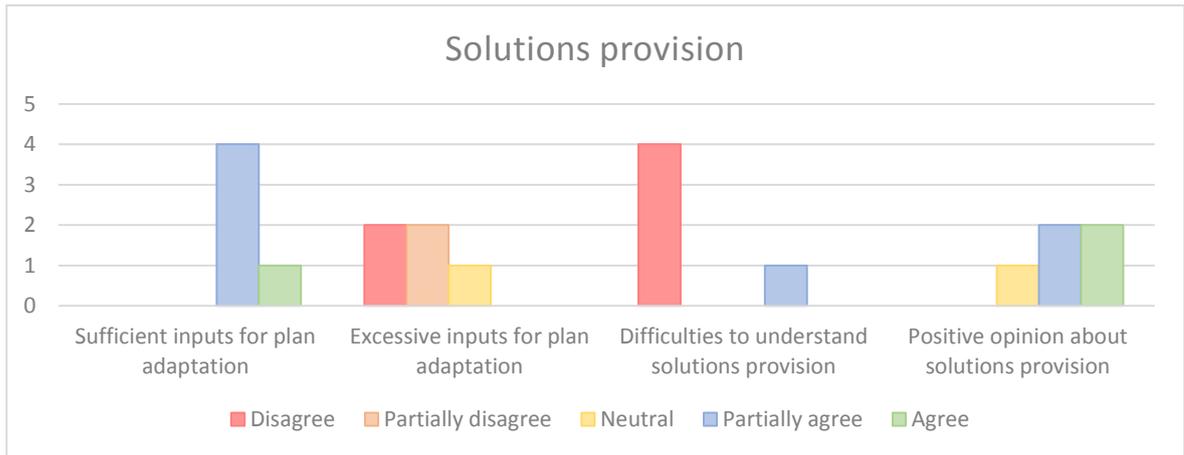


Figure 6-26: Second response team’s answers on information for providing solutions to identified problems

6.4.3 Consolidation analysis of experiments

All participants had some relation with the emergency domain (Figure 6-27), either working in different scenarios within this domain or being a member of the graduate program focusing on training professional to act in such domain. They also had different levels of experience in this domain, with most of them often dealing with high-pressure events for more than 5 years. In addition, there is also a difficulty in convening able people for research evaluation. Despite being a challenge to convene professionals with this very specific profile, it was required for gathering data as close as possible from reality to properly evaluate the proposed approach.

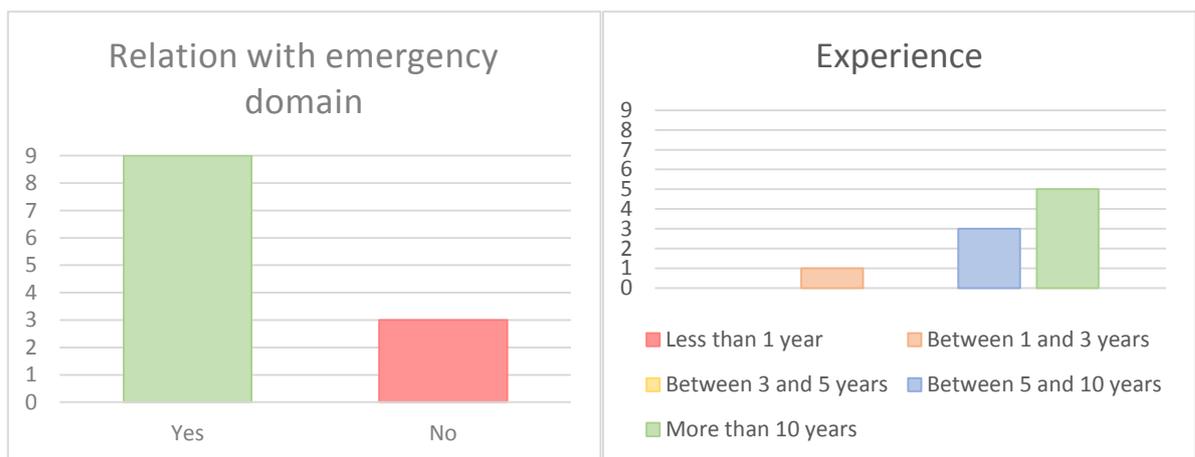


Figure 6-27: Participants profile

Regarding the plan presentation through the proposed elements (Figure 6-28), results show a positive opinion about it, with participants considering that the proposed presentation facilitates actions understanding and monitoring (10 and 9, respectively). However, it was not

so clear whether the proposed plan presentation is or is not more confusing than other plan presentation (7 participants are neutral). In addition, 7 participants reported difficulties to understand the plan presentation. These results and opinions provided during the experiments show a need for a training on proposed elements so that participants can understand the perspective change about the plan representation. It also indicates the need for a more detailed training about the use of provided tool features before the beginning of the experiment, so that participants get the best out of them.

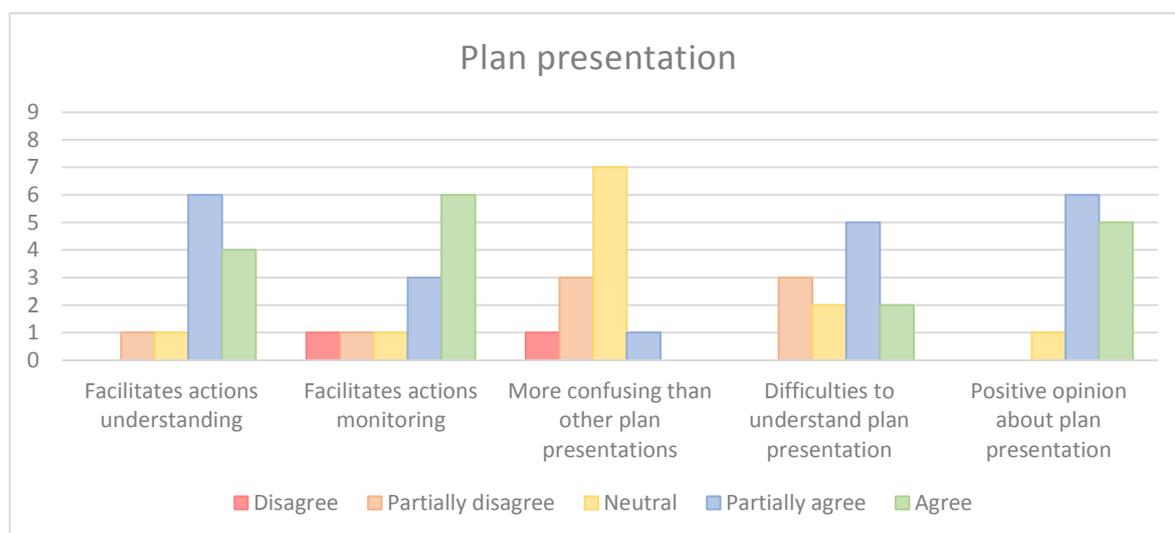


Figure 6-28: Results on plan presentation through proposed elements

Regarding the extra information about actions being performed (Figure 6-29), results show a positive opinion about it, with participants considering that provided information are relevant for understanding the action being performed and the current situation of emergency response (11 and 9, respectively) and that was not provided an excess of information for such end (8 and 9, respectively). However, participants reported that it is necessary additional information for understanding the action being performed and the current situation of emergency response (6 and 7, respectively). In addition, 7 participants reported difficulties to understand the plan detailing. These results and opinions provided during the experiments reinforce the need for a training on proposed elements and the use of provided tool features before the beginning of the experiment. In addition, it is necessary to provide additional inputs for monitoring the performed actions and current situation, which may impact the unforeseen situation analysis and decision making. Besides that, it shows the need for adjustments in the tool interface for better visualization of all provided information at the same time. It impacts participants' analysis and decision-making.

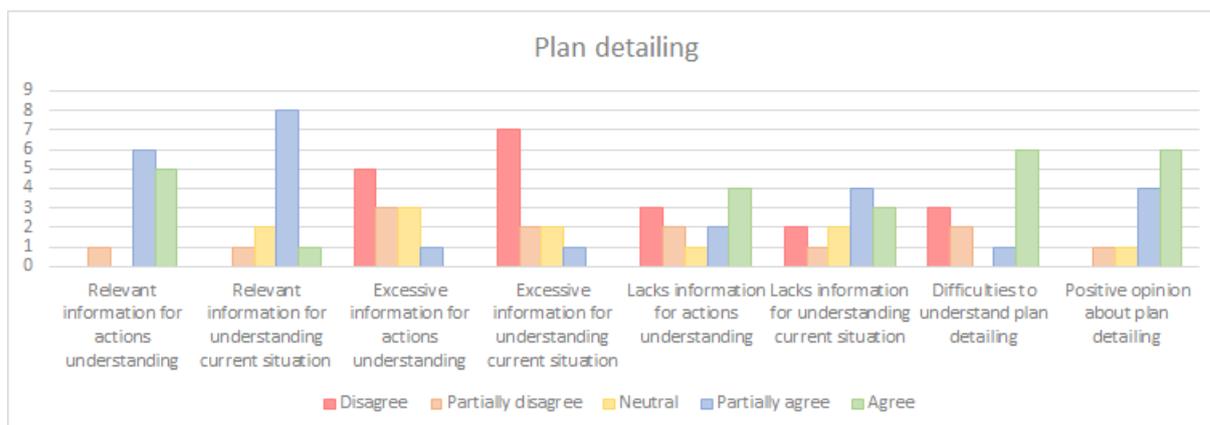


Figure 6-29: Results on extra information about actions

Regarding the perception mechanisms for indicating plan problems (Figure 6-30), results show a positive opinion about it, with participants considering that these mechanisms reduce the required time to identify problems and help to identify the problem causes (10 and 11, respectively). The difficulty to understand the mechanisms for indicating plan problems was lower than in the previous analyzed aspects, being reported by 4 participants. Despite that, it is also important to provide a more detailed training about the use of tool features so that participants get the best out of them.

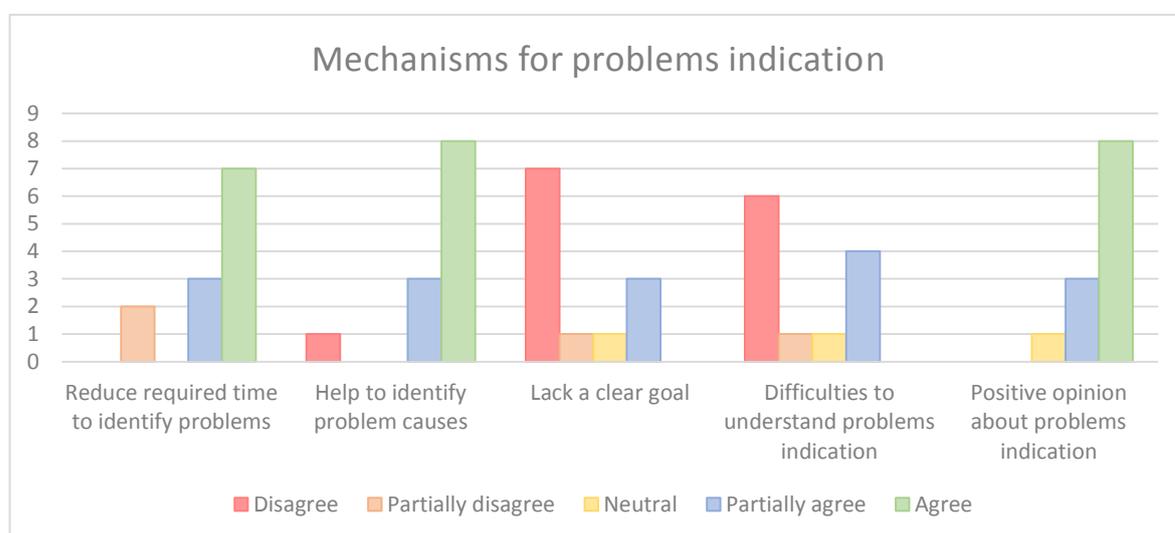


Figure 6-30: Results on mechanisms for indicating plan problems

Regarding the information for unforeseen situation analysis and characterization (Figure 6-31), results show a positive opinion about it, with all participants considering that provided information help to understand the current situation of the emergency response. However, 7 participants reported that it is necessary additional inputs for the unforeseen situation analysis. In addition, 6 participants reported difficulties to understand the provided

information. These results and opinions provided during the experiments reinforce the need for a training on proposed elements and the use of provided tool features before the beginning of the experiment. Besides that, it shows a participants' need to seek other inputs for performing a better unforeseen situation analysis and decision making, being necessary to provide additional knowledge for adaptation.

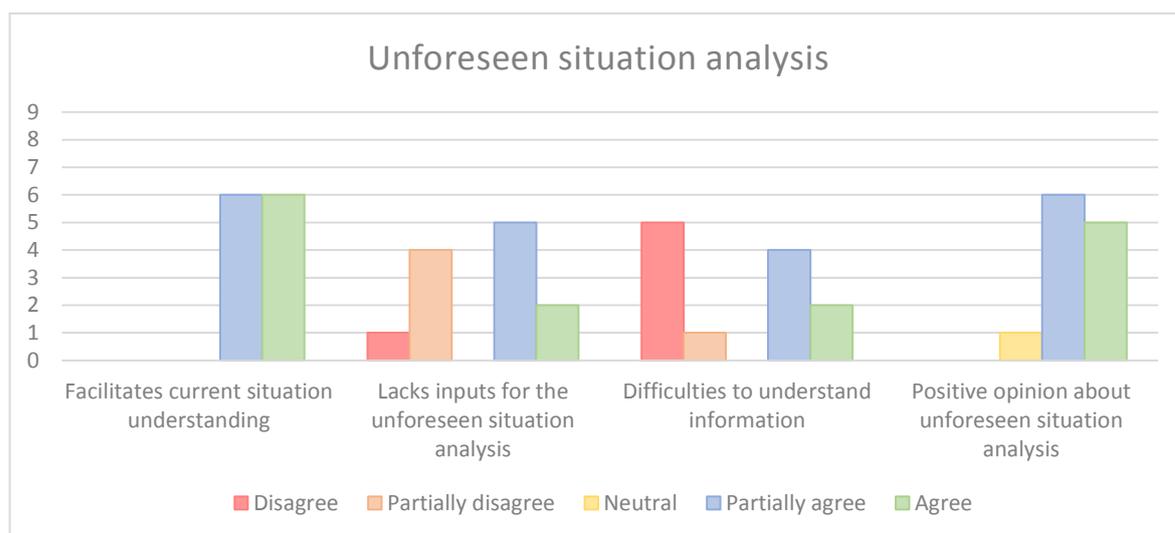


Figure 6-31: Results on information for unforeseen situation analysis

Regarding the perception mechanisms for indicating variable inconsistencies (Figure 6-32), results show a positive opinion about it, with participants considering that these mechanisms facilitate the analysis of plan problems, reduce the required time to identify problems and help to identify the problem causes (9, 9 and 9, respectively). 5 participants reported difficulties to understand the mechanisms for indicating inconsistencies. These results and opinions provided during the experiments reinforce the need for a training on the use of provided tool features before the beginning of the experiment. Besides that, it shows the need for adjustments in the tool for better visualization of the variables. It impacts participants' analysis and decision-making.

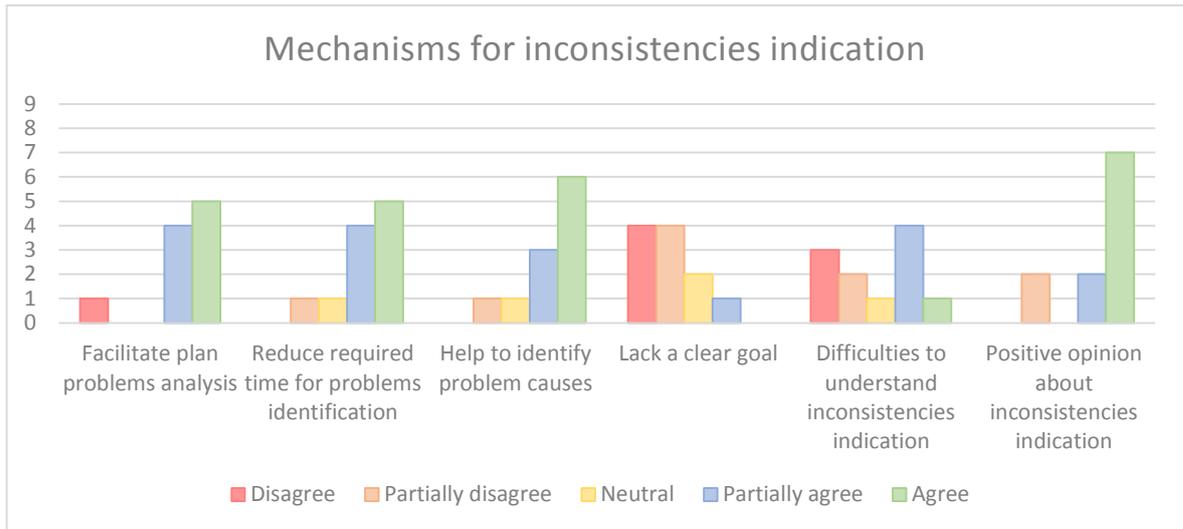


Figure 6-32: Results on mechanisms for indicating variable inconsistencies

Regarding the information for providing solutions to the identified problems (Figure 6-33), results show a positive opinion about it, with participants considering that provided information are sufficient for plan adaptation and that was not provided an excess of information for such end (9 and 10, respectively). The difficulty to understand the provision of solutions was lower than in the previous analyzed aspects, being reported by 5 participants. These results and opinions provided during the experiments reinforce the need for a training on the use of provided tool features before the beginning of the experiment. Besides that, it shows the need for adjustments in the tool to fully support the plan adaption.

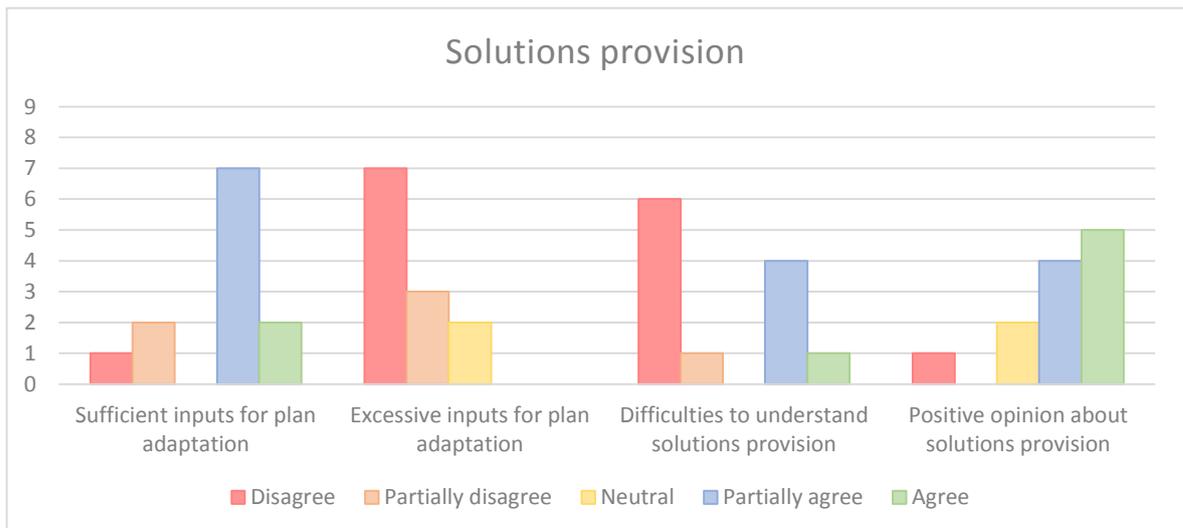


Figure 6-33: Results on information for providing solutions to identified problems

6.5 Comments about the experiments

The experiment presented how the Emergency Management domain demands several kinds of adaptation, occurring at different stages of the emergency response. It may face problems from the beginning, or rather starts well and changes unexpectedly.

Besides that, the experiment showed need to collaborate, share knowledge and negotiate for handling the scenario. During an emergency response, it is not only one expert diagnosing and handling the unexpected events and unforeseen situations arising from them, but a team that must collaborate and share knowledge towards making the best decision for the response. In addition, this team must negotiate and align different viewpoints because each member of the response team (a) is responsible for some information or is interested in a certain perspective of the emergency response, and (b) has different training and experience that may lead to a set of possible solutions to problems faced.

In addition, the experiment provided an opportunity for Civil Defense agents to simulate the use of a plan established by the Civil Defense from a different municipality. Although both Civil Defense agents are responsible for acting in the same scenarios, the adopted practices are different in some aspects, either by specific municipality characteristics, the existing structure and limitations for acting, the responsibilities of involved people etc. The goal and main actions are similar, but how these goals are achieved and actions will be performed, and who is responsible for performing such actions may vary according to the organization. Thus, the experiment was an opportunity for participants to rethink their work according to protocols normally adopted during their duties in Civil Defense of Niterói. Examples were found through phrases, such as *"We need to rethink the procedures we have been adopting in this situation"*, *"We have already sent an agent to an event without the key for manual activation"* and *"I cannot understand what is spoken at the loudspeaker. It is necessary to speak slowly"*, said during a discussion of possible solutions for some proposed unforeseen situations.

Participants from Mestrado em Defesa e Segurança Civil also had the opportunity to rethink their work and assess in which ways the proposed approach and tool could support their duties and which aspects still need to be improved.

The experiment also helped to evaluate the effectiveness of the approach for on-the-fly adaptation of plans in unforeseen situations. In addition, it allowed observing the impact of the proposed approach application and any opportunities for its improvement and/or

evolution. Furthermore, it is claimed that questions and analysis conducted during this experiment lead to conclusions that can be applied, expanded or generalized to other domains where irregular phenomena are identified.

However, some challenges were also identified during the experiment execution. The first challenge was the identification of plans that may be used during the proposal evaluation. Despite the emergency management domain allows recovering a great number of plans for different emergency events, they are detailed at a very high level of abstraction. They usually provide very general information related to the environment for which they were defined and the available resources. In addition, they describe a set of goals to be reached while handling a specific situation, but without detailing the actions taken to achieve this goal. It could impact the plan reformatting for the proposed elements since some elements may not be filled only with the information available in the plan. Moreover, it makes more difficult to identify unforeseen situations in the plan, what may generate a great number of plan adjustments. Interacting with domain experts was necessary so the plan be as complete as possible, thus reducing incomplete information and unnecessary work.

The second challenge concerns the impact of the participants' experience and viewpoints during the unforeseen situation interpretation. The unforeseen situation may be considered a demand for adaptation or something that requires no further action depending on participant's experience. This may demand a plan adaptation when it is unnecessary or lacks thereof when there is such a need. It is necessary to understand that members of the same team did not necessarily agree on diagnosing a demand for adaptation due to their different viewpoints.

The third challenge concerns the plan adaptation. The need for plan adaptation was identified during the experiment, but it could not be dynamically implemented due to limitations in the developed tool concerning the knowledge supporting adaptation, support to improvisation and solution organization. It is necessary to finish the implementation of these features so the plan adaptation aspect can be tested and the proposed approach be fully evaluated. Participants also highlight some reservations regarding tool and plan use in time of crisis, indicating the need for a dedicated professional to record all decisions made in the system. They reinforce that this professional must have a proper profile to think about something other than the faced emergency.

The fourth challenge concerns participants' training. The experiment indicated that there is still a need for training on the proposed elements so that participants can understand the perspective change about the plan representation. It also indicates the need for a more detailed training about the use of provided tool features before the beginning of the experiment, so that participants get the best out of them.

The fifth challenge concerns the developed tool. Besides finishing the implementation of features related to the plan adaptation, it is necessary to adjust the tool interface for a better visualization of state variables and all provided information at the same time. It impacts participants' analysis and decision-making.

Research evaluation is another important aspect to discuss. Irregular phenomena in complex environments, such as Emergency Management, are not simple to simulate in a laboratory. Thus, data from real cases was gathered to design a scenario, as close as possible to the reality faced by emergency response teams, in order to show the approach applicability and highlight the problems found during its application in heavy rains and possible solutions employed.

In addition, there is also a difficulty in inviting able people for research evaluation. Professionals with a very specific profile, whether from the emergency domain or other possible domains for research application, are required for the proper research evaluation.

7 Conclusion

This chapter revisits the main points discussed throughout the thesis, presenting the results obtained with the proposed solution and the research contributions. In addition, it details the proposal limitations identified during the experiment execution and future work.

7.1 Thesis summary

Being prepared for adaptation is important when working in complex environments, especially when handling irregular phenomena. Characteristics as subjective definitions, a variety of alternatives and combinations, dynamic execution, unexpected restrictions, unpredictable decisions and incremental response impose new difficulties in identifying a well-defined and viable way to handle these phenomena. Thus, during the plan application, it is common to face unforeseen situations, which may arise due to the lack of knowledge during planning, the application of the planned actions during the phenomenon handling, and/or by the situation evolution and the occurrence of events that are not expected during the phenomenon handling. As a result, the prior developed plan becomes inappropriate to be followed, being necessary to identify alternative solutions and make decisions at runtime to solve the identified unforeseen situation and handle the ongoing irregular phenomenon.

As stated before, irregular phenomena are a very rich context for research, providing different aspects to explore. Research opportunities are identified in both planning, handling and evaluation activities. Research on planning aims to design a plan that allows the definition or adaptation of the irregular phenomena at runtime, may anticipate the need for adaptation and facilitate the inclusion of new actions to the existing plan. Research on handling aims to apply, monitor and adjust a prior developed plan to be suitable for handling the ongoing phenomenon. Research on evaluation aims to collect and use information about the phenomenon handling as input for a plan evaluation, thus allowing the planning team may provide a more suitable plan for handling future irregular phenomena.

Within this scope, this thesis has focused on the handling activity. More specifically, it has addressed the difficulty in diagnosing unforeseen situations and adjusting prior developed plans during their application. Interviews with physicians and Civil Defense agents were carried out to confirm the problem existence, identify methods used to diagnose and handle,

at runtime, events and situations that were not foreseen in the plan, and list the main difficulties faced while carrying out these tasks.

The approach for on-the-fly adaptation of plans in unforeseen situations was proposed to assist the response team. By monitoring the selected plan, considering the phenomenon observed situation and a set of pre-defined parameters, it is possible to assess if this plan is still appropriate to be applied in the ongoing irregular phenomena or if some unforeseen situation has been identified and requires further analysis. If any unforeseen situation has occurred, the interpretation allows characterizing the unforeseen situation and determining if it has produced a disruption in the plan. When a disruption is reported, the plan adaptation allows the development and selection of alternative solutions to this disruption, which must be applied during the irregular phenomenon handling.

A tool has been developed to support the identification and interpretation of unforeseen situations during the prior developed plan application. It was used during two experiments in the emergency management domain. These experiments aimed to evaluate the applicability, contributions and limitations of the diagnosis aspect of the proposed approach.

7.2 Results

The experiment results indicate the feasibility of the proposal to deal with unforeseen situations while handling irregular phenomena in complex environments. It provides a more systematic way to handle unforeseen situations, besides a wider support to decision-making, by providing mechanisms that help the diagnosis and treatment of unforeseen situations, making the plan become suitable and effective for the actual situation faced. To conclude this, the results for the following aspects of the approach were considered.

The first aspect concerns the identification of unforeseen situations in the existing plan. The results indicate that all proposed unforeseen situations were quality and timely identified. Participants were also satisfied with provided mechanisms (plan presentation and detailing, and mechanisms for indicating plan problems) for unforeseen situations identification. However, it is still necessary to provide training on proposed plan elements and using the provided tool features.

The second aspect concerns the interpretation of unforeseen situations in the existing plan. The results indicate that all proposed unforeseen situations were quality and timely

handled. Participants were also satisfied with provided mechanisms (information for unforeseen situation analysis and characterization, and mechanisms for indicating variables inconsistencies) for unforeseen situations interpretation. However, it is still necessary to provide training on proposed plan elements and using the provided tool features, besides providing additional knowledge and making adjustments in tool interface for a better unforeseen situation analysis and decision making.

The third aspect concerns the adaptation of the incompatible plan. The results indicate that all disruptions have been provided with relevant solutions. Participants were also satisfied with provided mechanisms (information for providing solutions) for plan adaptation, although adaptation is still occurring in a limited way. However, it is still necessary to provide training on using the provided tool features, besides providing additional knowledge for a better unforeseen situation analysis and decision making.

7.3 Contributions

The main research contribution was the approach for on-the-fly adaptation of plans in unforeseen situations to, at runtime, diagnose unforeseen situations and adapt plans that have become unsuitable for handling the ongoing irregular phenomenon. Although there are other proposals to deal with unforeseen situations that impact the prior developed plans, which were cited in this thesis, the purpose of the present research differs from the others in two aspects:

- the support in the decision-making process for handling unforeseen situations as a whole, from the identification of unforeseen situations, going through the diagnosis of their impact on the existing plans, to performing adjustments to make the plan suitable for handling the unforeseen situation;
- dealing with both explicit and tacit knowledge to handle unforeseen situations, which allows identifying and diagnosing unforeseen situations and providing a wider range of alternative solutions for them.

Besides the main contribution, it is possible to highlight other contributions resulting from the thesis:

- Systematization of the decision-making process for dealing with unforeseen situations in dynamic environments and with high degree of unpredictability;

- If improvisation is unavoidable, providing a more structured improvisation since it will include information that guides the identification of alternative solutions.

Some products were also generated during this research:

- Requirements elicitation and development of computational prototype to support the proposed approach;
- Approach illustration and evaluation in example scenarios (healthcare domain and emergency management domain);
- Domain understanding and research dissemination through the papers Diirr et al. (2013), Diirr et al. (2015) and Diirr and Borges (2016), and research association to other research in Cordeiro et al. (in progress).

7.4 Limitations and future work

It is expected that the proposals presented throughout this thesis may be discussed and explored in future researches that address the diagnosis and handling of unforeseen situations in complex environments. These researches will help to re-evaluate and evolve the proposed approach.

Some aspects of the proposed approach still need a depth study. Concerning the procedure monitoring, the challenge is to reformat the recommended plan to the proposed elements (action-state-resource-event-goal). During reformatting, it is possible to identify missing information since some elements cannot be filled only by the information available in the existing plan. This interferes the identification of unforeseen situations and may generate unnecessary plan adaptations. Research on planning phase should provide mechanisms that support a better systematization of plan development and evolution activities.

Regarding the unforeseen situation interpretation, the challenge concerns the impact of the participants' experience during the comprehensive analysis. The unforeseen situation may be considered a demand for adaptation or something that requires no further action depending on participant's experience. This may demand adaptation when it is unnecessary or lacks thereof when there is such a need. It is expected that the provision of a complete prior knowledge base should reduce this problem since the response team can use more information to base its decision.

As for the plan adaptation, the challenge concerns to design a mechanism to support and systematize improvisation. A speculation guide should allow the response team to create new connections between the available resources and between these resources and their own experiences in other phenomena to devise a set of possible solutions for the disruption. Structuring a mechanism that guides and helps the externalization of tacit knowledge is not a trivial task. More than that, besides helping to externalize this knowledge, this guide should also enable the organization of knowledge, so it can be effectively applied in the unforeseen situation. I.e. it is necessary to identify mechanisms that facilitate the organization of the speculated knowledge according to the proposed elements before incorporating it into the existing plan. A guide that reduces the need to organize the speculated solutions into the proposed elements is still required.

The tool also requires further features development. In the current tool version, the plan is set internally. It is necessary to enable the recovery of plans that are stored externally to the tool and the tool configuration from this plan. It is also necessary to develop mechanisms that allow the plan redesign from its execution. In the current tool version, the information about the plan execution is stored in the system log and, if the planning team needs to improve the plan from this information, the planning team must analyze this log. Features related to plan adaptation, described in section 5.4, also need to be developed. Such features development will allow the evaluation of the approach aspects that could not be evaluated during the planned experiment.

In addition, new experiments should be conducted. An experiment focusing on the plan adaptation proposal is required to fully evaluate the approach for on-the-fly adaptation of plans in unforeseen situations. In addition, experiments in other domains would help to observe different impacts of applying the proposed approach. The results of such experiments serve as important inputs to the assessment and evolution of the proposed approach.

Finally, research on planning in irregular phenomena are is still open. The uncertainty and lack of knowledge about the environment must be recognized from the beginning of the plan development. From this perspective, demands for adaptation during the irregular phenomena handling are no longer ad-hoc, but something that can be minimally anticipated, which facilitates their treatment. Plans should be designed to highlight points that require special attention or are more likely to be changed during handling. It allows anticipating the

need for adaptation, predicting the impact that changes will have on the plan, and helping to include the information that emerges during handling into the existing plan.

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Glossary

This glossary details the definitions of terms used throughout the thesis. It aims to standardize the understanding of the adopted terms since there is no consensus about them. In addition, it provides a conceptual framework connecting these terms.

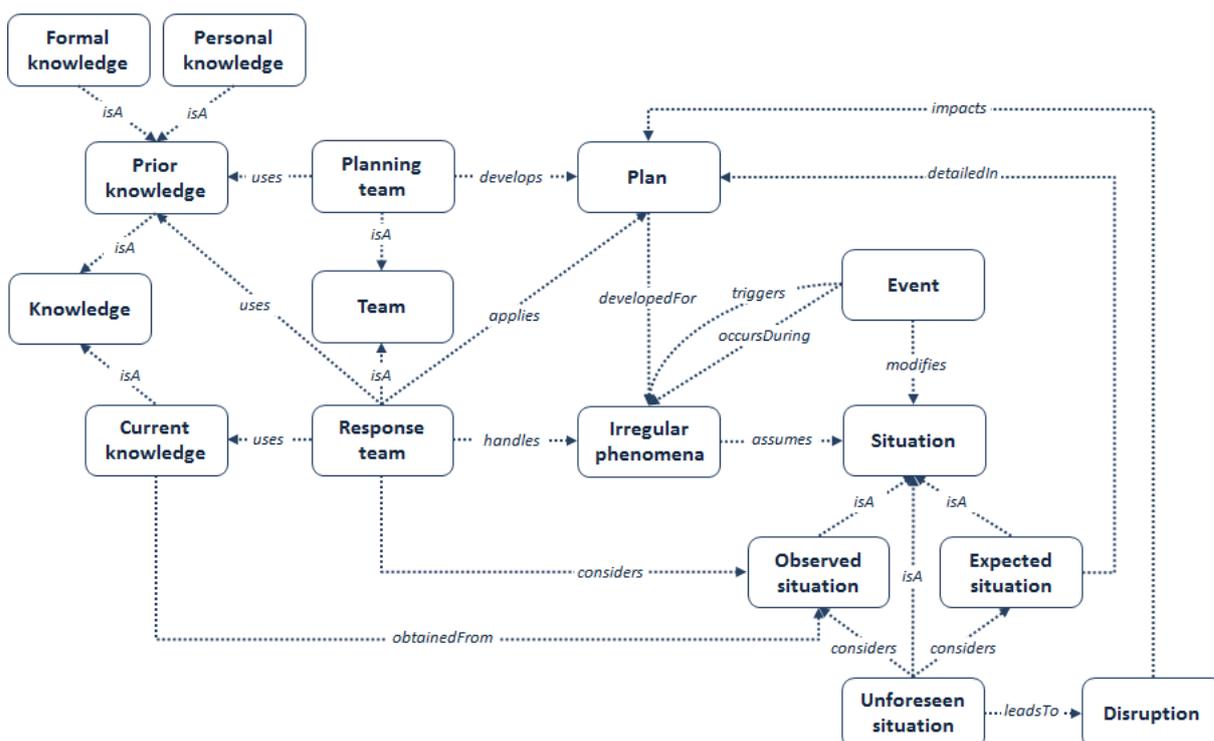
Term	Definition
Action	Atomic task performed to achieve a goal. It aims to take the phenomenon from one state to another by changing the state variables values and uses different resources. It is expressed through the task to be performed, the goal to be achieved and the necessary resources to execute it (DIIRR et al, 2013).
Case	A piece of contextual knowledge that records an episode where a problem has been totally or partially solved. In other words, it records an experience in dealing with a specific problem that contributes in some way with a better solution for it. It comprises (a) a description of the relevant aspects of the problem to be solved; (b) the description of the solution associated with the problem in terms of procedure, sequence of actions, diagnosis, classification, design etc.; and (c) an evaluation of the solution used to solve the problem (KOLODNER, 1993).
Context	A complex description of the shared knowledge about the physical, social and historical conditions, within which actions or events occur (BRÉZILLON, 1999). In other words, the context allows determining who, where, when, what and why certain circumstance occurs (ABOWD et al, 1999). The context awareness provides greater insight into the phenomenon.
Critical state variables	State variables that are more likely to cause negative impact if not properly handled and/or that must be considered as a priority during handling. They can be critical for the whole plan or for a specific action.
Current knowledge	All knowledge generated by the phenomena evolution and the consequences of the handling (DINIZ, 2005).
Disruption	Disturbance or problem that interrupts an event, activity or process to continue in its normal way (OXFORD). The disruption makes more difficult to the prior developed plan proceed as expected, and, as result, it may become no longer applicable to handle the ongoing phenomenon.
Event	Something that can change things from a pre-state to a post-state, thus representing a possible transformation from one situation to another situation in reality (GUIZZARDI and WAGNER, 2005). It has an impact on the state variables (DIIRR et al, 2013).
Goal	What should be achieved during handling. It may be composed of subgoals (DIIRR et al, 2013).

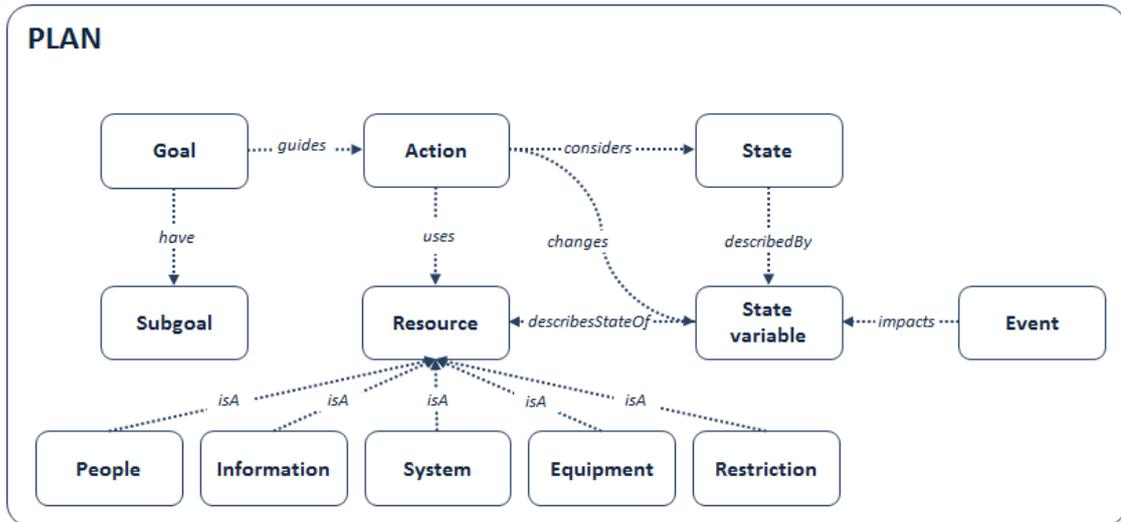
Term	Definition
Improvisation	The process that involves the interpretation of the phenomenon observed situation and the identified problems, the articulation of the available resources and the design of solutions for handling the disruption. It involves the recombination of the resources available for the phenomenon handling, including the selected plan, the situation awareness of the phenomenon, plans developed for similar phenomena, reports that describe how past phenomena were handled, personal experience in dealing with similar phenomena etc., to develop a solution for the identified disruption (LEWIS and LOVATT, 2013; LEY et al, 2012; LONG and YU, 2009; MENDONÇA and WALLACE, 2007; OXFORD; PRESSING, 1988; TAN and HALLO, 2008; WEICK, 1998).
Irregular phenomena	Phenomena that it is possible to imagine, but it is difficult to know all their details in advance, commonly face unpredicted events and unforeseen situations, and require creativity in performing actions and decision-making (DE MAN, 2009; FRANKE et al., 2010; LAKSHMANAN et al., 2012; RICHTER-VON HAGEN et al., 2005; SWENSON, 2010; WESTRUM, 2006; WHITE, 2009).
Lessons learned	The learning gained from a project realization (DUFFIELD and WHITTY, 2012; PMI, 2013), which helps to transfer the experience and knowledge gained from a specific project to new projects in order to improve future performance (BUTTLER and LUKOSCH, 2013).
Non-critical state variables	State variables that do not cause negative impact if not properly handled and/or does not need to be considered as a priority during handling.
Phenomena	Something (fact or event) that happens or exists and that can be observed or experienced (MERRIAM-WEBSTER; OXFORD). Events occur during phenomena, changing the phenomenon observed situation to another situation. This new situation may be an expected situation or an unforeseen situation.
Phenomenon expected situation	The situation that is described in the plan.
Phenomenon observed situation	The situation that is observed during the phenomenon evolution.
Phenomenon unforeseen situation	The situation where the expected situation evolution does not match the observed situation evolution. They may arise due to the lack of knowledge during planning, the application of the planned actions during the phenomenon handling and/or by the occurrence of events that are not expected during the phenomenon handling, and may lead to plan disruptions.

Term	Definition
Plan	An artifact that defines a set of actions that must be followed to achieve a goal within a specific timeframe (SCHANK and ABELSON, 1975). It describes a set of possible events and situations arising from them, and details what must be done, when, where, how and by whom, besides being described scenarios related to the best, expected and worst case (BUSINESS DICTIONARY; OXFORD; THE FREE DICTIONARY). This information is elicited and can be described through natural language (textual documents), or informal (illustrations with steps) or formal (Petri net and business processes) graphical representations.
Planning team	A group of people who are responsible for detailing a set of possible events and situations arising from them, and devising what must be done, when, where, how and by whom, to handle phenomena occurring in a complex environment.
Prior knowledge	Any knowledge that exists about the phenomenon before its occurrence and need for handling. It may be a formal knowledge, which is detailed in documents as plans, guides and reports describing prior handling, or a personal knowledge, which exists in the mind of the response team and was obtained during past experiences in phenomena with similar characteristics, training and simulations (DINIZ, 2005).
Process	The sequence of dependent and interconnected actions, which consume one or more resources (human, energy, equipment, money etc.) to convert inputs (data, material, components, etc.) into outputs. These outputs serve as input for the next action until a known goal or result (products or services with value to the client) is reached (BUSINESS DICTIONARY; DUMAS et al., 2013; RICHTER-VON HAGEN et al., 2005; SHARP and MCDERMOTT, 2009).
Referents or schemas	General knowledge structures that people use daily to predict and understand what is expected in different problems (BARTLETT, 1932 apud: LEWIS and LOVATT, 2013; PRESSING, 1998). Throughout life, people subconsciously build up a large array of schemas/referents that drive their expectations and organize their knowledge of the world.
Regular phenomena	Phenomena that allow an easier identification of all possible events that may occur and detailing the situations assumed during phenomena in advance. They are well-known, possess a specific and detailed pattern, and allow an advance planning and repeated execution (HAMACHER; RAMDAS, 2011; SWENSON, 2010; WESTRUM, 2006).
Resource	A set of elements that is necessary to perform an action (DIIRR et al, 2013).
Response team	A group of people who are responsible for deciding and taking actions to handle phenomena occurring in a complex environment. These people may be organized into different response teams, such as (a) the control team, which manages the information coming from different sources and controls people working in the field; and (b) the operation team, which is in the field to handle the phenomenon.

Term	Definition
Situation	A set of circumstances (facts, conditions and events) in which someone or something finds oneself at a specific time and place (MERRIAM-WEBSTER; OXFORD).
Situation awareness	The ability to identify, process and understand the information about what is happening with the response team at any given time and space, besides predicting how this condition will change over time and how external factors might affect the circumstance faced (ENDSLEY, 1988; HADDOW et al, 2011; MERRICK and DUFFY, 2013; UNITED STATES COAST GUARD, 1998).
State	Characterization of the phenomenon at a specific moment. The state is expressed through a set of variables, which has associated values that may change over time (DIIRR et al, 2013).
State variable	Variables that describes a state, comprising people involved, required information, required systems, required material resource, existing restrictions, estimated elapsed time at that point of the phenomenon handling, estimated cost at that point of the phenomenon handling and expected action result. It has associated values that may change over time and can be classified as critical or non-critical state variable (DIIRR et al, 2013).
Validity range	Ranges of values within which the conditions for handling each (critical or not) state variables remain valid for the ongoing phenomena.

CONCEPTUAL FRAMEWORK OF GLOSSARY





Appendix 1 – Contingency plan for heavy rains

This appendix uses the elements proposed by the approach for on-the-fly adaptation of plans to detail the contingency plan for heavy rains. Information about the contingency plan was obtained from SUBDEC (2015a), SUBDEC (2015b), SUBDEC (2015c), Annex 1, Annex 2 and meetings with agents at (a) Coordenação do Sistema de Defesa Civil (COSIDEC) on 09/Aug/2016, and (b) Centro de Operações Rio (COR) on 12/Aug/2016.

Initial state	Action
<p>People involved: Civil Defense (COR)</p> <p>Required information: Current “Alerta Rio” stage Current rain level/area/hour Radar information</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario</p> <p>Required material resource: Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Monitor meteorological conditions</p>
<p>People involved: Civil Defense (COR)</p> <p>Required information: Current “Alerta Rio” stage Current rain level/area/hour Radar information Scale shift</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario WhatsApp Email</p> <p>Required material resource: Cellphone Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Send team to Alerta Rio and Control room</p>

Initial state	Action
<p>People involved: Civil Defense (COR)</p> <p>Required information: Current "Alerta Rio" stage Current rain level/area/hour Radar information Alarm status/area</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.be/externo/alertario</p> <p>Required material resource: Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Check alarm status</p>
<p>People involved: Civil Defense (COR) Responsible for alarm maintenance</p> <p>Required information: Current "Alerta Rio" stage Current rain level/area/hour Alarm status/area Contact information (telephone number)</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.be/externo/alertario</p> <p>Required material resource: Telephone Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Contact responsible</p>

Initial state	Action
<p>People involved: Civil Defense (COR)</p> <p>Required information: Current “Alerta Rio” stage = Attention Current rain level/area/hour Radar information Authorization of Civil Defense Coordinator Recipient list (telephone number)</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.be/externo/alertario Site sms2.streamtel.com.br (SMS sending)</p> <p>Required material resource: Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Send SMS to citizens</p>
<p>People involved: Civil Defense (COR) Agentes Comunitários de Saúde (ACS) Community leaders</p> <p>Required information: Current “Alerta Rio” stage = Attention Current rain level/area/hour Radar information Authorization of Civil Defense Coordinator Recipient list (telephone number)</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.be/externo/alertario Site sms2.streamtel.com.br (SMS sending)</p> <p>Required material resource: Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Send SMS to ACS and community leaders</p>

Initial state	Action
<p>People involved: Civil Defense (COR) Agentes Comunitários de Saúde (ACS) Community leaders</p> <p>Required information: Current “Alerta Rio” stage = Attention Current rain level/area/hour Radar information Alarm status/area Recipient list (telephone number)</p> <p>Required systems: -</p> <p>Required material resource: Telephone number</p> <p>Existing restrictions: -</p>	<p>Check SMS</p>
<p>People involved: Civil Defense (COR) Agentes Comunitários de Saúde (ACS) Community leaders</p> <p>Required information: Current “Alerta Rio” stage = Crisis Current rain level/area/hour Radar information Alarm status/area Community leaders list (telephone number)</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario Site sms2.streamtel.com.br (SMS send)</p> <p>Required material resource: Telephone</p> <p>Existing restrictions: -</p>	<p>Mobilize community leaders</p>

Initial state	Action
<p>People involved: Civil Defense (COR)</p> <p>Required information: Current “Alerta Rio” stage = Crisis Current rain level/area >55mm in 1h; >150mm in 24h and 5mm/h; >275mm in 96h and 5mm/h Radar information Alarm status/area</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.be/externo/alertario</p> <p>Required material resource: Internet infrastructure</p> <p>Existing restrictions: The minimum period of the alarm condition will be (a) 2 (two) hours, in case of alarm activation based on the criteria of 1h accumulated rainfall; (b) 3 (three) hours, in case of alarm activation based on the criteria of 24h accumulated rainfall; (c) 4 (four) hours, in case of alarm activation based on the criteria of 96h accumulated rainfall.</p>	<p>Activate mobilization alarm</p>
<p>People involved: Civil Defense (COR) Agentes Comunitários de Saúde (ACS) Community leaders</p> <p>Required information: Current “Alerta Rio” stage = Crisis Current rain level/area >55mm in 1h; >150mm in 24h and 5mm/h; >275mm in 96h and 5mm/h Radar information ACS and Community leaders list (telephone number)</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.be/externo/alertario</p> <p>Required material resource: Internet infrastructure Telephone</p> <p>Existing restrictions: -</p>	<p>Check alarm</p>

Initial state	Action
<p>People involved: Civil Defense (COR) Community leader Civil Defense agent</p> <p>Required information: Current "Alerta Rio" stage = Crisis Current rain level/area >55mm in 1h; >150mm in 24h and 5mm/h; >275mm in 96h and 5mm/h Radar information Alarm status/area Community leaders list (telephone number) Non-working alarm confirmation</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario</p> <p>Required material resource: Internet infrastructure Alarm area keys Alarm</p> <p>Existing restrictions: The manual operation must be performed by the technical team, Civil Defense agent or trained and authorized person of the community (preferably the community leader).</p>	<p>Manual activation</p>

Initial state	Action
<p>People involved: Civil Defense (COR) Agentes Comunitários de Saúde (ACS) Community leaders Civil Defense agent</p> <p>Required information: Current “Alerta Rio” stage = Crisis Current rain level/area >55mm in 1h; >150mm in 24h and 5mm/h; >275mm in 96h and 5mm/h Radar information Alarm status/area Non-working alarm confirmation</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario</p> <p>Required material resource: Internet infrastructure Whistles</p> <p>Existing restrictions: -</p>	<p>Use alternative alarm mechanism</p>
<p>People involved: Civil Defense (COR) Secretaria Municipal de Assistência Social (SMAS)</p> <p>Required information: Current “Alerta Rio” stage = Crisis Current rain level/area >55mm in 1h; >150mm in 24h and 5mm/h; >275mm in 96h and 5mm/h Radar information Alarm status/area SMAS contact (telephone number)</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario</p> <p>Required material resource: Telephone Internet infrastructure</p> <p>Existing restrictions: -</p>	<p>Mobilize SMAS</p>

Initial state	Action
<p>People involved:</p> <ul style="list-style-type: none"> Civil Defense (COR) Agentes Comunitários de Saúde (ACS) Community leaders Civil Defense agent Secretaria Municipal de Assistência Social (SMAS) <p>Required information:</p> <ul style="list-style-type: none"> Current “Alerta Rio” stage = Crisis Current rain level/area/hour Radar information Alarm status/area Safety area location Identified issues (via 199) <p>Required systems:</p> <ul style="list-style-type: none"> Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario Site www.sgrc.rio.gov.br <p>Required material resource:</p> <ul style="list-style-type: none"> Internet infrastructure Telephone <p>Existing restrictions:</p> <ul style="list-style-type: none"> - 	<p>Monitor safety area</p>

Initial state	Action
<p>People involved: Civil Defense (COR)</p> <p>Required information: Current "Alerta Rio" stage = Crisis Current rain level/area <2mm in 2h when alarm activation in case of mm/h; <2mm in 3h when alarm activation in case of mm/24h; <2mm in 4h when alarm activation in case of mm/96h Radar information Alarm list/Risk area Weather forecast is rain <5mm/h</p> <p>Required systems: Site websirene.rio.rj.gov.br Site riomidia.cor.rio.gov.br/externo/alertario</p> <p>Required material resource: Internet infrastructure</p> <p>Existing restrictions: The demobilization alarm should only be activated after checking the following conditions: (a) when the criteria used to alarm activation (mm/h, mm/24h and mm/96h) is not being observed; (b) when there is enough natural light; (c) if the accumulated rain is up to 2 mm/h for: 2 (two) consecutive hours, in case of alarm activation by mm/h; 3 (three) consecutive hours, in case of alarm activation by mm/24h; and 4 (four) consecutive hours, in case of alarm activation by mm/96h; and (d) short-term weather forecast (next two hours) in the region is rain lower than 5 mm/h.</p>	<p>Activate demobilization alarm</p>

Appendix 2 – Adopted scenario for heavy rains

This appendix shows the adopted scenario for approach evaluation. Useful information was obtained from Annex 2, Annex 3, Annex 4 and meetings with agents at (a) Coordenação do Sistema de Defesa Civil (COSIDEC) on 09/Aug/2016, and (b) Centro de Operações Rio (COR) on 12/Aug/2016. All messages and meteorological conditions were provided to participants along the experiment via support tool and/or datashow.

Scenario description							
January in the city of Rio de Janeiro. Historically, it is a period of heavy rains and hot weather. The forecast indicates many clouds over the city and the possibility of heavy rains in the late afternoon/early evening. Some rain showers were identified in different areas of the city at 17h30 and the current weather conditions are:							
Rainfall data - 17h30							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	1/0	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaiiba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

Beginning of the experiment

-----after 10s in action "Monitor meteorological conditions"-----

– Alerta Rio informs that there is an increase in rain intensity

-----after 30s-----

– Alerta Rio publishes the rainfall data at 17h45

– Light rain over regions IV-Laranjeiras, V-Copacabana, XII-Tomás Coelho, XIV-Vila Kosmos, XV-Vaz Lobo, XVI-Praça Seca and XXIV-Itanhangá

– Moderate rain over regions IV-Laranjeiras, V-Copacabana, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos and XV-Vaz Lobo

Rainfall data - 17h45							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieux)	XXVII	Rocinha	1/0	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaiba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 30s-----

– Civil Defense coordinator informs that the team has reached the pre-attention stage

-----after 10s in action "Send team to Alerta Rio and Control room"-----

– The team has arrived at Alerta Rio and Control room.

-----after 15s in action "Check alarm status"-----

– Team has been informed that the alarms in some regions are off-line

-----as soon as action "Contact responsible" begin-----

– Call to: 99999-9999

-----after 5s-----

– It was not possible to contact the responsible company. Number is out of coverage area

-----after 5s in action “Monitor meteorological conditions”-----

- Alerta Rio informs that the city has reached the attention stage

-----after 10s-----

- Alerta Rio publishes the rainfall data at 18h
- Light rain over regions XVI-Praça Seca
- Moderate rain over regions IV-Laranjeiras, V-Copacabana, VI-Vidigal, XXVII-Rocinha, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo and XXIV-Itanhangá
- Heavy rain over regions XII-Tomás Coelho, XIII-Lins and XV-Vaz Lobo

Rainfall data - 18h							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomás Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomás Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieux)	XXVII	Rocinha	1/0	Mineiros	XIII	Piñares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaíba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Piñares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 10s in action “Send SMS to citizens”-----

- Civil Defense coordinator could not be reached to authorize the SMS sending

-----after 15s in action “Send SMS to ACS and community leaders”-----

- Some telephone numbers do not exist or are outdated.

-----after 10s in action “Monitor meteorological conditions”-----

– Alerta Rio informs that the city has reached the crisis stage

-----after 10s-----

– Alerta Rio publishes the rainfall data at 19h

– Moderate rain over regions IV-Laranjeiras, V-Copacabana, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho, XIV-Vila Kosmos, XVI-Praça Seca and XVIV-Itanhangá

– Heavy rain over regions IV-Laranjeiras, V-Copacabana, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo and XVIV-Itanhangá

– Extreme rain over regions VI-Vidigal, XXVII-Rocinha and XIII-Lins

Rainfall data - 19h							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	1/0	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaíba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 15s in action “Mobilize community leaders”-----

– Some telephone numbers do not exist or are outdated.

-----after 10s in action "Monitor meteorological conditions"-----

– Extreme rains hit the city, endangering people living in risk areas.

-----after 10s-----

– Alerta Rio publishes the rainfall data at 19h15

– Moderate rain over regions IV-Laranjeiras, V-Copacabana, X-Olaria, XI-Penha, XXIX-Alemão and XII-Tomás Coelho

– Heavy rain over regions IV-Laranjeiras, V-Copacabana, XVI-Praça Seca and XVIV-Itanhangá

– Extreme rain over regions VI-Vidigal, XXVII-Rocinha, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo and XVIV-Itanhangá

Rainfall data - 19h15							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomás Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomás Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieux)	XXVII	Rocinha	1/0	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaiba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapé 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 5s in action "Check alarm"-----

– Alarms on regions Sereno, Engenho da Rainha and Espírito Santo was not activated.

-----after 15s in action "Manual activation"-----

–Some telephone numbers do not exist or are outdated.

-----after 5s in action "Mobilize SMAS"-----

– SMAS has teams to assist (five) regions at the same time.

-----after 5s in action "Monitor safety area"-----

– Civil Defense has teams to assist 3 (three) regions at the same time due to the number of available vehicles.

-----after 30s-----

– Rua Quiririm safety area has not been open yet.

-----after 3min-----

– Alerta Rio publishes the rainfall data at 19h45

– Light rain over regions IV-Laranjeiras

– Moderate rain over regions IV-Laranjeiras, V-Copacabana, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho and XIV-Vila Kosmos

– Heavy rain over regions IV-Laranjeiras, XIII-Lins, XVI-Praça Seca and XV-Itanhangá

– Extreme rain over regions VI-Vidigal, XXVII-Rocinha, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo and XV-Itanhangá

Rainfall data - 19h45							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomás Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomás Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	1/0	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaiba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 1min-----

- Alerta Rio publishes the rainfall data at 20h
- Light rain over regions IV-Laranjeiras, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho and XIV-Vila Kosmos
- Moderate rain over regions IV-Laranjeiras, V-Copacabana, VI-Vidigal and XIII-Lins
- Heavy rain over regions XXVII-Rocinha, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo, XVI-Praça Seca and XXIV-Itanhangá

Rainfall data - 20h							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	1/0	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaiba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 1min-----

- Field team informs that alarm from Mineiros has stopped working.

-----after 3min-----

- Alerta Rio publishes the rainfall data at 20h15
- Light rain over regions IV-Laranjeiras, V-Copacabana, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho and XIV-Vila Kosmos
- Moderate rain over regions IV-Laranjeiras, V-Copacabana, VI-Vidigal, XXVII-Rocinha, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo, XVI-Praça Seca and XXIV-Itanhangá

Rainfall data - 20h15							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomás Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomás Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	0/1	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaiba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 1min-----

- Alerta Rio publishes the rainfall data at 20h30
- Light rain over regions IV-Laranjeiras, V-Copacabana, VI-Vidigal, X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho, XIII-Lins, XIV-Vila Kosmos, XV-Vaz Lobo, XVI-Praça Seca and XXIV-Itanhangá
- Moderate rain over regions V-Copacabana, XXVII-Rocinha and XXIV-Itanhangá

Rainfall data - 20h30							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	0/1	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaíba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 1min-----

- Rainfall data published by Alerta Rio does not indicate significant changes

-----after 1min-----

- Alerta Rio publishes the rainfall data at 23h30
- Light rain over regions IV-Laranjeiras, V-Copacabana, XXVII-Rocinha, XII-Tomás Coelho, XIII-Lins, XVI-Praça Seca and XVIV-Itanhangá

Rainfall data - 23h30							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,0-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	0/1	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaíba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 1min-----

- Alerta Rio publishes the rainfall data at 0h30
- Light rain over regions X-Olaria, XI-Penha, XXIX-Alemão, XII-Tomás Coelho and XIV-Vila Kosmos

Rainfall data - 0h30							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	0/1	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaíba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 1min-----

- Alerta Rio publishes the rainfall data at 1h30
- No rain in the city and the forecast does not show rain in the next hours

Rainfall data - 1h30							
Rain intensity: Light (0,2-5mm/h) - Moderate (5,1-25mm/h) - Heavy (25,1-50mm/h) - Extreme (>50mm/h)							
Sirenes On/Off	Pluviometer	Region	District	Sirenes On/Off	Pluviometer	Region	District
1/0	Guararapes 1	IV	Cosme Velho	1/1	Engenho da Rainha 1	XII	Engenho da Rainha
1/1	Santa Marta 1	IV	Botafogo	2/0	Parque Nova Maracá 1	XII	Tomas Coelho
0/1	Tabajaras 1	IV	Botafogo	2/1	Parque Silva Vale 3	XII	Tomas Coelho
1/0	Vila Pereira da Silva	IV	Laranjeiras	1/0	Relicário 1	XII	Inhaúma
2/0	Cabritos 1	V	Copacabana	2/0	Cachoeirinha 1	XIII	Lins de Vasconcelos
2/0	Cantagalo 1	V	Copacabana	1/0	Cotia 1	XIII	Lins de Vasconcelos
1/1	Chapéu Mangueira 1	V	Leme	0/1	Nossa Senhora da Guia 1	XIII	Lins de Vasconcelos
2/1	Pavão-Pavãozinho 3	V	Copacabana	1/0	Vila Cabuçu 1	XIII	Lins de Vasconcelos
3/1	Vidigal 3	VI	Vidigal	1/0	Matriz	XIII	Lins de Vasconcelos
5/2	Rocinha 8 (Laborieaux)	XXVII	Rocinha	0/1	Mineiros	XIII	Pilares
1/1	Cariri 1	X	Olaria	3/1	São João 2	XIII	Lins de Vasconcelos
1/1	Caracol 1	XI	Penha	2/0	Morro do Céu 2	XIII	Lins de Vasconcelos
0/1	Guaíba / V. Pequeri1	XI	Brás de Pina	2/0	Ouro Preto 2	XIII	Lins de Vasconcelos
2/0	Morro da Fé 1	XI	Penha	2/2	Urubu 2	XIII	Pilares
1/0	Sereno 1	XI	Penha	1/0	Rua Brício de Moraes 1	XIV	Thomas Coelho
1/0	Adeus 1	XXIX	Alemão	1/1	Jardim do Carmo 1	XIV	Vila Kosmos
1/1	Piancó 2	XXIX	Alemão	4/0	Juramento 2	XIV	Vicente de Carvalho
1/0	Baiana 1	XXIX	Alemão	0/1	São Miguel Arcanjo 1	XV	Madureira
2/0	Alemão 1 (Armando Sodre)	XXIX	Alemão	2/0	Sapê 1	XV	Vaz Lobo
2/1	Joaquim de Queiróz 1 (Canitar)	XXIX	Alemão	3/0	Barão 1	XVI	Praça Seca
1/0	Nova Brasília 1	XXIX	Alemão	1/0	Comandante Luiz Souto 1	XVI	Praça Seca
2/0	Parque Alvorada 2	XXIX	Alemão	1/0	Espírito Santo 1	XVI	Praça Seca
2/0	Palmeira 2	XXIX	Alemão	1/1	Rua Quiririm 1	XVI	Vila Valqueire
2/0	Vila Cruzeiro 1	XXIX	Alemão	1/0	Ignácio Dias 1	XVI	Jacarepaguá
				2/0	Rio das Pedras 1	XVIV	Jacarepaguá
				1/0	Sítio Pai João 1	XVIV	Itanhangá

-----after 10s in action "Activate demobilization alarm"-----
– Alarms are disabled in all regions.

Appendix 3 – Planned unforeseen situations

This appendix classifies the planned unforeseen situations according to the level of difficulty to identify or solve them, considering the needed time, required effort and associated uncertainty (GRILL and HICKS, 2006 apud: LI et al., 2011).

Task difficulty	Unforeseen situation
Easy	Team has been informed that the alarms in some regions are off-line
Medium	It was not possible to contact the responsible company. Number is out of coverage area
Hard	Civil Defense coordinator could not be reached to authorize the SMS sending
Easy	Some telephone numbers do not exist or are outdated
Easy	Some telephone numbers do not exist or are outdated
Medium	Alarms on regions Sereno, Engenho da Rainha and Espírito Santo was not activated
Easy	Some telephone numbers do not exist or are outdated
Hard	SMAS has teams to assist (five) regions at the same time
Hard	Civil Defense has teams to assist 3 (three) regions at the same time due to the number of available vehicles
Medium	Rua Quiririm safety area has not been open yet
Medium	Field team informs that alarm from Mineiros has stopped working

Appendix 4 – Questionnaire

This appendix details the questionnaire answered by the experiment participants to gather information that supports the proposed approach evaluation.

Unforeseen situation identification

1. Regarding the plan presentation (flow)

	Disagree	Partially disagree	Neutral	Partially agree	Agree
Facilitates actions understanding	<input type="radio"/>				
Facilitates actions monitoring	<input type="radio"/>				
It is more confusing than other plan presentations	<input type="radio"/>				
I have difficulties to understand the plan presentation	<input type="radio"/>				
I have a positive opinion about the plan presentation	<input type="radio"/>				

In which ways do you think the plan presentation has helped and/or hampered the unforeseen situation identification?

2. Regarding the plan detailing (additional information about actions being performed)

	Disagree	Partially disagree	Neutral	Partially agree	Agree
Provides relevant information for actions understanding	<input type="radio"/>				
Provides relevant information for understanding the current situation of emergency response	<input type="radio"/>				
Provides excessive information for actions understanding	<input type="radio"/>				
Provides excessive information for understanding the current situation of emergency response	<input type="radio"/>				
Do not provide all required information for actions understanding	<input type="radio"/>				
Do not provide all required information for understanding the current situation of emergency response	<input type="radio"/>				
I have difficulties to understand the plan detailing	<input type="radio"/>				
I have a positive opinion about the plan detailing	<input type="radio"/>				

In which ways do you think the plan detailing has helped and/or hampered the unforeseen situation identification?

5. Regarding the mechanisms for indication variable inconsistencies

	Disagree	Partially disagree	Neutral	Partially agree	Agree
Facilitate the plan problems analysis	<input type="radio"/>				
Reduce the required time for identifying problems	<input type="radio"/>				
Help to identify what were the problem causes	<input type="radio"/>				
Have not a clear goal	<input type="radio"/>				
I have difficulties to understand the variable inconsistencies indication	<input type="radio"/>				
I have a positive opinion about the mechanisms for indicating variable inconsistencies	<input type="radio"/>				
In which ways do you think these mechanisms have helped and/or hampered the unforeseen situation identification?					
<div style="border: 1px solid #ccc; height: 40px; width: 100%;"></div>					

Plan adaptation

6. Regarding the information for providing solutions to problems

	Disagree	Partially disagree	Neutral	Partially agree	Agree
Provides sufficient inputs for plan adaptation	<input type="radio"/>				
Provides excessive inputs for plan adaptation	<input type="radio"/>				
I have difficulties to understand the solutions provision	<input type="radio"/>				
I have a positive opinion about the information for providing solutions to problems	<input type="radio"/>				
In which ways do you think this information has helped and/or hampered the unforeseen situation identification?					
<div style="border: 1px solid #ccc; height: 40px; width: 100%;"></div>					

Additional comments

7. Do you have suggestions/criticisms about any relevant point that were not discussed above?

8. Inform your email if you agree to be contacted in case of doubts and/or informed about experiment results

Profile

9. Do you have any relation with the emergency domain? It is not necessary to act in rains/Civil Defense

Yes

No

If so, how are you connected to emergencies (role or connection)?

10. How long do you work in this domain?

Less than 1 year

Between 1 and 3 years

Between 3 and 5 years

Between 5 and 10 years

More than 10 years

Annex 1 – ABC da chuva



PREFEITURA DA CIDADE DO RIO DE JANEIRO
Secretaria Municipal de Conservação e Serviços Públicos
Subsecretaria de Defesa Civil



ABC DA CHUVA

Guia Rápido: <omitted for information security>

A) NUCLEOS DE CHUVA NO RADAR:

1. Ligar para quartéis e informar à chefia sobre a condição das chuvas.
2. Abrir Guia-Rápido, Websirene e sites de envio de mensagens.

B) PRÉ-ATENÇÃO

1. Equipe deve mandar alguém para sala do Alerta Rio e Sala de Controle. Este, deve sempre informar sobre atualizações da meteorologia.
2. Pegar planilha de Sirenes por A.P. - Selecionar Sirenes (de acordo com o deslocamento dos núcleos)

Exemplo: núcleos de chuva vindo pela Baixada Flu. - selecionar A.P. que pode ser afetada, ou seja, AP3.1, 3.2 e 3.3.

C) INICIO DA CHUVA

1. Ao verificar volume de chuva forte, entrar em contato com os Núcleos de Defesa Civil das áreas de risco (Pontos de Apoio, Líderes Comunitários) - verificar condições da chuva e se há ocorrências.
2. Caso o volume de chuva se aproxime do índice de acionamento às Sirenes, entrar em contato com Pontos de Apoio e solicitar sua abertura.

* **COMUNICAÇÃO:** Preferencialmente, utilizaremos o grupo Whatsapp - DCMRJ. Caso não haja consenso, por se tratar de um recurso pessoal, será obrigatório a utilização do supervisoroperacional@gmail.com.

Annex 2 – Guia rápido COR



PREFEITURA DA CIDADE DO RIO DE JANEIRO
Secretaria Municipal de Conservação e Serviços Públicos
Subsecretaria de Defesa Civil



GUIA RÁPIDO - COR

Conteúdo: principais documentos e sistemas de apoio às atividades da Defesa Civil Rio

[LISTAGEM PONTOS DE APOIO E ESTAÇÕES SONORAS](#)

[CONTATOS](#)

[WEBSIRENE - ACIONAMENTOS](#)

[RADAR SUMARE](#)

[SMS - STREAMTEL / ZENVIA](#)

[SGRC](#)

[SIRENES POR A.P.](#)

[MENSAGENS SMS \(MODELOS / PADRÃO\)](#)

[ESCALA DE PLANTÕES](#)

[SISTEMA COMANDO](#)

[ACS- CONATOS](#)

LISTAGEM PONTOS DE APOIO E ESTAÇÕES SONORAS

<omitted for information security>

CONTATOS

<omitted for information security>

WEBSIRENE - ACIONAMENTOS

<http://websirene.rio.rj.gov.br> <omitted for information security>

RADAR SUMARE

<http://riomidia.cor.rio.gov.br/externo/alertario/>

SMS - STREAMTEL / ZENVIA

<http://sms2.streamtel.com.br/> (<omitted for information security>)

<https://goo.gl/b79cNe> (Zenvia)

SGRC

<https://goo.gl/oxBocz> (<omitted for information security>).

SIRENES POR A.P.

<https://goo.gl/h5rvt0> (Cada Area de Planejamento com as suas respectivas Sirenes).

MENSAGENS SMS (MODELOS / PADRÃO)

AVISO:

DefCivil: areas de instabilidade deverao provocar pancadas de chuva na Cidade RJ, nas proximas horas. ACS/LidCom, fiquem atentos (23/03) Emerg 199.

ACIONAMENTO:

DefCivil: chuva provoca risco de deslizamento/desabamento. ACS/LidCom mobilizar moradores de areas de risco para pontos de apoio (29/02) Emerg 199.

GRUPOS PARA ENVIO DO SMS

AP 1.0 - Centro, Mangueira, Rio Comprido, San
 AP 2.1 - Copacabana, Laranjeiras, Leme
 AP 2.2 - Andaraí, Grajaú, Tijuca, Vila Isabel
 AP 3.1 - Complexo Alemão, Ilha Governador
 AP 3.2 - Engenho Novo, Inhaúma, Lins Vasconcellos
 AP 3.3 - Irajá, Madureira, Tomás Coelho
 AP 4.0 - Barra Tijuca, Jacarepaguá
 AP 5.1 - Realengo, Bangu
 AP 5.2 - Campo Grande, Guaratiba
 AP 5.3 - Santa Cruz

LID.COM AP 1.0 - Centro, Mangueira, Rio Comp, Sant
 LID.COM AP 2.1 - Copacabana, Laranjeiras
 LID.COM AP 2.2 - Andaraí, Grajaú, Tijuca, Vila Isa
 LID.COM AP 3.1 - Complexo do Alemão
 LID.COM AP 3.2 - Engenho Novo, Ihaúma, Lins, Meier
 LID.COM AP 3.3 - Irajá, Madureira, Tomaz Coelho, V
 LID.COM AP 4.0 - Barra da Tijuca, Jacarepaguá, Ita
 LID.COM ILHA DO GOVERNADOR

Autoridades - Prefeitura do Rio
 Defesa Civil - Funcionais
 Defesa Civil - Particulares
 Desenvolvimento Social - SMDS

ESCALA DE PLANTÕES

<omitted for information security>

SISTEMA COMANDO

<http://10.50.73.0:8080/comando/faces/home.xhtml> (<omitted for information security>)

ACS- CONATOS

<omitted for information security>

BACIAS HIDROGRÁFICAS / AP



Annex 3 – Warning system activation

This annex shows only the data about the rain occurred on 16/jan/2014 (SUBDEC, 2016), which was adopted during the experiment. This decision is due to the size of the spreadsheet that SUBDEC uses to control all warning system simulations and activation.

ACIONAMENTOS DE ESTAÇÕES SONORAS REALIZADOS em 16/jan/14

ORDEM	NOME		ORDEM	NOME		ORDEM	NOME		ORDEM	NOME	
1	ADEUS		34	GUÁIBA		67	PRAZERES		100	VILA JOSÉ DE ANCHIETA	2
2	ALEMÃO	2	35	GUARARAPES		68	PRETOS FORROS	2	101	VILA MATINHA	
3	ANDARAÍ		36	INÁCIO DIAS		69	QUETO		102	VILA PEQUIRI	
4	ARRELIA		37	JAMELÃO		70	RATO		103	VILA PEREIRA DA SILVA	
5	AZEVEDO LIMA		38	JARDIM DO CARMO	2	71	RELICÁRIO		TOTAL		
6	BABILÔNIA		39	JOAQUIM DE QUEIROZ	2	72	RIO DAS PEDRAS		27		
7	BACIA		40	JÚLIO OTONI		73	ROCINHA	2			
8	BAIANA		41	JURAMENTO	2	74	RUA BRÍCIO DE MORAES	2			
9	BARÃO	2	42	LADEIRA DOS TABAJARAS		75	RUA FREI GASPAR				
10	BARRO PRETO	2	43	LIBERDADE		76	RUA LAUDELINO FREIRE				
11	BARRO VERMELHO		44	MACACOS		77	RUA MIRA				
12	BISPO		45	MANGUEIRA		78	RUA QUIRIRIM	2			
13	BOREL		46	MATINHA		79	SALGUEIRO				
14	CABRITOS		47	MATRIZ		80	SANTA ALEXANDRINA/PAULA RAMOS				
15	CACHOEIRA GRANDE	2	48	MINEIROS		81	SANTA MARTA				
16	CACHOEIRINHA	2	49	MORRO DA FÉ		82	SANTA TEREZINHA	2			
17	CAIXA D'ÁGUA		50	MORRO DO CÉU	2	83	SANTOS RODRIGUES (QUEROSENE)				
18	CANTAGALO		51	N. S. GUIA	2	84	SÃO CARLOS				
19	CARACOL		52	NOVA BRASÍLIA		85	SÃO JOÃO				
20	CARIRI (MERINDIBA)		53	NOVA DIVINÉIA		86	SÃO MIGUEL ARCANJO	2			
21	CATUMBI (MINEIRA)		54	OCIDENTAL FALLET		87	SAPÉ				
22	CHÁCARA DO CÉU		55	OURO PRETO		88	SERENO				
23	CHACRINHA		56	PALMEIRAS		89	SITIO PAI JOÃO				
24	CHAPÉU MANGUEIRA		57	PANTANAL		90	SUMARE				
25	COMANDANTE LUIS SOUTO		58	PARQUE ALVORADA		91	TELÉGRAFOS				
26	COTIA	2	59	PARQUE CANDELÁRIA		92	TRAVESSA ANTONINA	2			
27	DONA FRANCISCA	2	60	PARQUE JOÃO PAULO II / JK		93	TUIUTI				
28	ENCONTRO		61	PARQUE NOVA MARACÁ	2	94	UNIDOS SANTA TEREZA				
29	ENGENHO DA RAINHA	2	62	PARQUE PROLETÁRIO DO GROTÃO		95	URUBU	2			
30	ESCONDIDINHO		63	PARQUE SILVA VALE	2	96	VIDIGAL	2			
31	ESPÍRITO SANTO	2	64	PARQUE VILA ISABEL		97	VILA CABUÇU	2			
32	FAZENDA CATETE		65	PAVÃO / PAVÃOZINHO		98	VILA CRUZEIRO				
33	FORMIGA		66	PIANCÓ		99	VILA ELZA				

Annex 4 – Evolution of 16/jan/2014 rain

This annex shows data provided by Alerta Rio about the evolution of the rain that occurred in Rio de Janeiro on 16/jan/2014. This specific rain was selected because (a) it was the rain with the greatest impact in 2014 (D'ORSI et al, 2015); (b) it has demanded the activation of 27 alarms (the third largest alarm activation by Civil Defense, losing just to the rain that occurred on 12/mar/2016 – 36 alarms activated – and the rain that occurred on 11/dec/2013 – 48 alarms activated); and (c) the availability of a detailed data (rainfall data from 17h until 1h30).

N. 1 A	Identificação		Chuvvas										Alarmes	
	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...		
1	Vidigal	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo
2	Urca	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo
3	Rocinha	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	0.0	Baixo
4	Tijuca	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	8.4	0.0	0.0	Baixo
5	Santa Teresa	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.0	0.0	Baixo
6	Copacabana	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo
7	Grajaú	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.2	30.2	0.0	0.0	Baixo
8	Ilha do Governador	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	9.8	0.0	0.0	Baixo
9	Penha	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.4	17.8	0.0	0.0	Baixo
10	Madureira	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	9.4	0.0	0.0	Baixo
11	Irajá	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	17.0	0.0	0.0	Baixo
12	Bangu	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.4	0.0	0.0	Baixo
13	Piedade	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.2	20.6	0.0	0.0	Baixo
14	Jacarepaguá/Tanque	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	13.6	0.0	0.0	Baixo
15	Saúde	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.2	0.0	0.0	Baixo
16	Jardim Botânico	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	Baixo
17	Barra/Barrinha	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	Baixo
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.8	0.0	0.0	Baixo
19	Barra/Riocentro	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	0.0	Baixo
20	Guaratiba	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	48.2	0.0	0.0	Baixo
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	15.6	0.0	0.0	Baixo
22	Santa Cruz	16/01/2014 - 17:00:00	0.0	0.2	0.2	0.2	0.2	0.2	0.2	4.4	24.6	0.0	0.0	Baixo
23	Grande Méier	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0	23.0	0.0	0.0	Baixo
24	Anchieta	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	6.4	0.0	0.0	Baixo
25	Grota Funda	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.4	0.0	0.0	Baixo
26	Campo Grande	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	Baixo
27	Sepetiba	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	37.6	0.0	0.0	Baixo
28	Alto da Boa Vista	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	6.6	0.0	0.0	Baixo
29	Av. Brasil/Mendanha	16/01/2014 - 17:00:00	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.6	4.2	1.6	0.0	Baixo
30	Recreio dos Bandeirantes	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.8	0.0	0.0	Baixo
31	Laranjeiras	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	0.0	Baixo
32	São Cristóvão	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.0	0.0	0.0	Baixo
33	Tijuca/Muda	16/01/2014 - 17:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.2	15.2	0.0	0.0	Baixo

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo	
2	Urca	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo	
3	Rocinha	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	Baixo	
4	Tijuca	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	8.4	Baixo	
5	Santa Teresa	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	Baixo	
6	Copacabana	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo	
7	Grajaú	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.2	30.2	Baixo	
8	Ilha do Governador	16/01/2014 - 17:30:00	9.0	9.0	9.0	9.0	9.0	9.0	17.2	18.8	36.0	Baixo	
9	Penha	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	16.4	17.8	0.0	Baixo	
10	Madureira	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	9.4	9.4	0.0	Baixo	
11	Irajá	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	17.0	17.0	0.0	Baixo	
12	Bangu	16/01/2014 - 17:30:00	0.2	0.2	0.2	0.2	0.2	0.2	0.2	14.6	0.8	Baixo	
13	Piedade	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	20.2	20.6	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	13.6	13.6	0.0	Baixo	
15	Saúde	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.2	0.0	Baixo	
16	Jardim Botânico	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	Baixo	
17	Barra/Barrinha	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.8	0.0	Baixo	
19	Barra/Riocentro	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	Baixo	
20	Guaratiba	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	6.4	48.2	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	13.8	15.6	0.0	Baixo	
22	Santa Cruz	16/01/2014 - 17:30:00	0.0	0.2	0.2	0.2	0.2	0.2	4.4	24.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	23.0	23.0	0.0	Baixo	
24	Anchieta	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	6.4	6.4	0.0	Baixo	
25	Grota Funda	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.4	0.0	Baixo	
26	Campo Grande	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	Baixo	
27	Sepetiba	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	2.0	37.6	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	4.0	6.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 17:30:00	0.0	0.6	0.6	0.6	0.6	0.6	1.8	4.4	0.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.8	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	Baixo	
32	São Cristóvão	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.0	0.0	Baixo	
33	Tijuca/Muda	16/01/2014 - 17:30:00	0.0	0.0	0.0	0.0	0.0	0.0	15.2	15.2	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo	
2	Urca	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo	
3	Rocinha	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	Baixo	
4	Tijuca	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	8.4	8.4	0.0	Baixo	
5	Santa Teresa	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.0	Baixo	
6	Copacabana	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baixo	
7	Grajaú	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	30.2	30.2	0.0	Baixo	
8	Ilha do Governador	16/01/2014 - 17:45:00	7.6	16.6	16.6	16.6	16.6	16.6	24.8	26.4	30.4	Baixo	
9	Penha	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	16.4	17.8	0.0	Baixo	
10	Madureira	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	9.4	9.4	0.0	Baixo	
11	Irajá	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	17.0	17.0	0.0	Baixo	
12	Bangu	16/01/2014 - 17:45:00	0.4	0.6	0.6	0.6	0.6	0.6	0.6	15.0	1.6	Baixo	
13	Piedade	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	20.2	20.6	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	13.6	13.6	0.0	Baixo	
15	Saúde	16/01/2014 - 17:45:00	1.8	1.8	1.8	1.8	1.8	1.8	5.8	6.0	7.2	Baixo	
16	Jardim Botânico	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	Baixo	
17	Barra/Barrinha	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.8	0.0	Baixo	
19	Barra/Riocentro	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	Baixo	
20	Guaratiba	16/01/2014 - 17:45:00	2.0	2.0	2.0	2.0	2.0	2.0	8.4	50.2	8.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	13.8	15.6	0.0	Baixo	
22	Santa Cruz	16/01/2014 - 17:45:00	0.0	0.0	0.2	0.2	0.2	0.2	4.4	24.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	23.0	23.0	0.0	Baixo	
24	Anchieta	16/01/2014 - 17:45:00	0.6	0.6	0.6	0.6	0.6	0.6	7.0	7.0	2.4	Baixo	
25	Grota Funda	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.4	0.0	Baixo	
26	Campo Grande	16/01/2014 - 17:45:00	1.2	1.2	1.2	1.2	1.2	1.2	1.2	5.6	4.8	Baixo	
27	Sepetiba	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	2.0	37.6	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	4.0	6.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 17:45:00	0.0	0.6	0.6	0.6	0.6	0.6	1.8	4.4	0.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.8	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	Baixo	
32	São Cristóvão	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.0	0.0	Baixo	
33	Tijuca/Muda	16/01/2014 - 17:45:00	0.0	0.0	0.0	0.0	0.0	0.0	15.2	15.2	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 18:00:00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Baixo	
2	Urca	16/01/2014 - 18:00:00	10,2	10,2	10,2	10,2	10,2	10,2	10,2	10,2	40,8	Baixo	
3	Rocinha	16/01/2014 - 18:00:00	0,0	0,0	0,0	0,0	0,0	0,0	0,8	0,8	0,0	Baixo	
4	Tijuca	16/01/2014 - 18:00:00	1,4	1,4	1,4	1,4	1,4	1,4	9,8	9,8	5,6	Baixo	
5	Santa Teresa	16/01/2014 - 18:00:00	6,0	6,0	6,0	6,0	6,0	6,0	6,4	6,6	24,0	Baixo	
6	Copacabana	16/01/2014 - 18:00:00	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,8	Baixo	
7	Grajaú	16/01/2014 - 18:00:00	6,0	6,0	6,0	6,0	6,0	6,0	36,2	36,2	24,0	Baixo	
8	Ilha do Governador	16/01/2014 - 18:00:00	1,4	18,0	18,0	18,0	18,0	18,0	26,2	27,8	5,6	Baixo	
9	Penha	16/01/2014 - 18:00:00	6,8	6,8	6,8	6,8	6,8	6,8	23,2	24,6	27,2	Baixo	
10	Madureira	16/01/2014 - 18:00:00	0,6	0,6	0,6	0,6	0,6	0,6	10,0	10,0	2,4	Baixo	
11	Irajá	16/01/2014 - 18:00:00	9,2	9,2	9,2	9,2	9,2	9,2	26,2	26,2	36,8	Baixo	
12	Bangu	16/01/2014 - 18:00:00	1,2	1,8	1,8	1,8	1,8	1,8	1,8	16,2	4,8	Baixo	
13	Piedade	16/01/2014 - 18:00:00	6,0	6,0	6,0	6,0	6,0	6,0	26,2	26,6	24,0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 18:00:00	1,6	1,6	1,6	1,6	1,6	1,6	13,2	13,2	6,4	Baixo	
15	Saúde	16/01/2014 - 18:00:00	16,0	17,8	17,8	17,8	17,8	17,8	21,8	22,0	64,0	Baixo	
16	Jardim Botânico	16/01/2014 - 18:00:00	0,4	0,4	0,4	0,4	0,4	0,4	0,6	0,6	1,6	Baixo	
17	Barra/Barrinha	16/01/2014 - 18:00:00	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,4	0,0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 18:00:00	5,0	5,0	5,0	5,0	5,0	5,0	8,8	8,8	20,0	Baixo	
19	Barra/Riocentro	16/01/2014 - 18:00:00	0,6	0,6	0,6	0,6	0,6	0,6	1,4	1,4	2,4	Baixo	
20	Guaratiba	16/01/2014 - 18:00:00	1,0	3,0	3,0	3,0	3,0	3,0	9,4	51,2	4,0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 18:00:00	15,0	15,0	15,0	15,0	15,0	15,0	28,8	30,6	60,0	Baixo	
22	Santa Cruz	16/01/2014 - 18:00:00	1,0	1,0	1,2	1,2	1,2	1,2	5,4	25,6	4,0	Baixo	
23	Grande Méier	16/01/2014 - 18:00:00	2,6	2,6	2,6	2,6	2,6	2,6	25,6	25,6	10,4	Baixo	
24	Anchieta	16/01/2014 - 18:00:00	8,0	8,6	8,6	8,6	8,6	8,6	15,0	15,0	32,0	Baixo	
25	Grota Funda	16/01/2014 - 18:00:00	0,0	0,0	0,0	0,0	0,0	0,0	1,6	9,4	0,0	Baixo	
26	Campo Grande	16/01/2014 - 18:00:00	0,6	1,8	1,8	1,8	1,8	1,8	1,8	6,2	2,4	Baixo	
27	Sepetiba	16/01/2014 - 18:00:00	0,4	0,4	0,4	0,4	0,4	0,4	2,4	38,0	1,6	Baixo	
28	Alto da Boa Vista	16/01/2014 - 18:00:00	0,8	0,8	0,8	0,8	0,8	0,8	4,8	7,4	3,2	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 18:00:00	0,0	0,2	0,6	0,6	0,6	0,6	1,8	4,4	0,0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 18:00:00	0,2	0,2	0,2	0,2	0,2	0,2	2,0	2,0	0,8	Baixo	
31	Laranjeiras	16/01/2014 - 18:00:00	11,8	11,8	11,8	11,8	11,8	11,8	12,0	12,2	47,2	Baixo	
32	São Cristóvão	16/01/2014 - 18:00:00	1,6	1,6	1,6	1,6	1,6	1,6	19,6	19,6	6,4	Baixo	
33	Tijuca/Muda	16/01/2014 - 18:00:00	4,2	4,2	4,2	4,2	4,2	4,2	19,4	19,4	16,8	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 18:15:00	15,8	15,8	15,8	15,8	15,8	15,8	15,8	15,8	63,2	Baixo	
2	Urca	16/01/2014 - 18:15:00	9,6	19,8	19,8	19,8	19,8	19,8	19,8	19,8	38,4	Baixo	
3	Rocinha	16/01/2014 - 18:15:00	16,4	16,4	16,4	16,4	16,4	16,4	17,2	17,2	65,6	Baixo	
4	Tijuca	16/01/2014 - 18:15:00	1,8	3,2	3,2	3,2	3,2	3,2	11,6	11,6	7,2	Baixo	
5	Santa Teresa	16/01/2014 - 18:15:00	5,4	11,4	11,4	11,4	11,4	11,4	11,8	12,0	21,6	Baixo	
6	Copacabana	16/01/2014 - 18:15:00	18,2	18,4	18,4	18,4	18,4	18,4	18,4	18,4	72,8	Baixo	
7	Grajaú	16/01/2014 - 18:15:00	34,2	40,2	40,2	40,2	40,2	40,2	70,4	70,4	136,8	Médio - 01h	
8	Ilha do Governador	16/01/2014 - 18:15:00	0,4	18,4	18,4	18,4	18,4	18,4	26,6	28,2	1,6	Baixo	
9	Penha	16/01/2014 - 18:15:00	10,2	17,0	17,0	17,0	17,0	17,0	33,4	34,8	40,8	Baixo	
10	Madureira	16/01/2014 - 18:15:00	17,2	17,8	17,8	17,8	17,8	17,8	27,2	27,2	68,8	Baixo	
11	Irajá	16/01/2014 - 18:15:00	19,2	28,4	28,4	28,4	28,4	28,4	45,4	45,4	76,8	Médio - 01h	
12	Bangu	16/01/2014 - 18:15:00	0,0	1,8	1,8	1,8	1,8	1,8	1,8	16,2	0,0	Baixo	
13	Piedade	16/01/2014 - 18:15:00	17,8	23,8	23,8	23,8	23,8	23,8	44,0	44,4	71,2	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 18:15:00	2,6	4,2	4,2	4,2	4,2	4,2	17,8	17,8	10,4	Baixo	
15	Saúde	16/01/2014 - 18:15:00	3,6	21,4	21,4	21,4	21,4	21,4	25,4	25,6	14,4	Baixo	
16	Jardim Botânico	16/01/2014 - 18:15:00	18,6	19,0	19,0	19,0	19,0	19,0	19,2	19,2	74,4	Baixo	
17	Barra/Barrinha	16/01/2014 - 18:15:00	5,8	5,8	5,8	5,8	5,8	5,8	6,2	6,2	23,2	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 18:15:00	3,8	8,8	8,8	8,8	8,8	8,8	12,6	12,6	15,2	Baixo	
19	Barra/Riocentro	16/01/2014 - 18:15:00	6,2	6,8	6,8	6,8	6,8	6,8	7,6	7,6	24,8	Baixo	
20	Guaratiba	16/01/2014 - 18:15:00	4,8	7,8	7,8	7,8	7,8	7,8	14,2	56,0	19,2	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 18:15:00	28,6	43,6	43,6	43,6	43,6	43,6	57,4	59,2	114,4	Médio - 01h	
22	Santa Cruz	16/01/2014 - 18:15:00	25,6	26,6	26,8	26,8	26,8	26,8	31,0	51,2	102,4	Médio - 01h	
23	Grande Méier	16/01/2014 - 18:15:00	25,2	27,8	27,8	27,8	27,8	27,8	50,8	50,8	100,8	Médio - 01h	
24	Anchieta	16/01/2014 - 18:15:00	3,8	12,4	12,4	12,4	12,4	12,4	18,8	18,8	15,2	Baixo	
25	Grota Funda	16/01/2014 - 18:15:00	1,6	1,6	1,6	1,6	1,6	1,6	3,2	11,0	6,4	Baixo	
26	Campo Grande	16/01/2014 - 18:15:00	12,0	13,8	13,8	13,8	13,8	13,8	13,8	18,2	48,0	Baixo	
27	Sepetiba	16/01/2014 - 18:15:00	0,0	0,4	0,4	0,4	0,4	0,4	2,4	38,0	0,0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 18:15:00	31,0	31,8	31,8	31,8	31,8	31,8	35,8	38,4	124,0	Médio - 01h	
29	Av. Brasil/Mendanha	16/01/2014 - 18:15:00	4,4	4,4	5,0	5,0	5,0	5,0	6,2	8,8	17,6	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 18:15:00	1,6	1,8	1,8	1,8	1,8	1,8	3,6	3,6	6,4	Baixo	
31	Laranjeiras	16/01/2014 - 18:15:00	9,4	21,2	21,2	21,2	21,2	21,2	21,4	21,6	37,6	Baixo	
32	São Cristóvão	16/01/2014 - 18:15:00	0,4	2,0	2,0	2,0	2,0	2,0	20,0	20,0	1,6	Baixo	
33	Tijuca/Muda	16/01/2014 - 18:15:00	11,2	15,4	ND	15,4	15,4	15,4	30,6	30,6	44,8	Baixo	

Identificação			Chuvvas										Alarmes
N. 1	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 18:30:00	39,8	34,8	34,8	34,8	34,8	34,8	34,8	34,8	136,0	Alto - 01h	
2	Urca	16/01/2014 - 18:30:00	1,2	21,0	21,0	21,0	21,0	21,0	21,0	21,0	4,8	Baixo	
3	Rosinha	16/01/2014 - 18:30:00	33,8	30,2	30,2	30,2	30,2	30,2	31,8	31,8	133,2	Alto - 01h	
4	Tijuca	16/01/2014 - 18:30:00	0,4	3,6	3,6	3,6	3,6	3,6	12,0	12,0	1,6	Baixo	
5	Santa Teresa	16/01/2014 - 18:30:00	0,4	11,8	11,8	11,8	11,8	11,8	12,2	12,4	1,6	Baixo	
6	Copacabana	16/01/2014 - 18:30:00	8,4	26,8	26,8	26,8	26,8	26,8	26,8	26,8	33,6	Médio - 01h	
7	Grajas	16/01/2014 - 18:30:00	30,8	31,0	31,0	31,0	31,0	31,0	31,0	31,0	63,0	Alto - 01h	
8	Ilha do Governador	16/01/2014 - 18:30:00	0,2	9,6	18,6	18,6	18,6	18,6	26,8	28,4	0,8	Baixo	
9	Penha	16/01/2014 - 18:30:00	4,0	21,0	21,0	21,0	21,0	21,0	37,4	38,8	16,0	Baixo	
10	Madureira	16/01/2014 - 18:30:00	19,2	37,0	37,0	37,0	37,0	37,0	46,4	46,4	76,8	Médio - 01h	
11	Irajá	16/01/2014 - 18:30:00	17,0	45,4	45,4	45,4	45,4	45,4	62,4	62,4	68,0	Médio - 01h	
12	Bangu	16/01/2014 - 18:30:00	3,6	5,2	5,4	5,4	5,4	5,4	5,4	19,8	14,4	Baixo	
13	Piedade	16/01/2014 - 18:30:00	18,8	42,6	42,6	42,6	42,6	42,6	62,8	63,2	75,2	Médio - 01h	
14	Jacarepaguá/Tanque	16/01/2014 - 18:30:00	6,2	10,4	10,4	10,4	10,4	10,4	24,0	24,0	24,8	Baixo	
15	Saúde	16/01/2014 - 18:30:00	0,8	22,2	22,2	22,2	22,2	22,2	26,2	26,4	3,2	Baixo	
16	Jardim Botânico	16/01/2014 - 18:30:00	16,4	35,4	35,4	35,4	35,4	35,4	35,6	35,6	65,6	Médio - 01h	
17	Barra/Barrinha	16/01/2014 - 18:30:00	20,4	26,2	26,2	26,2	26,2	26,2	26,6	26,6	81,6	Médio - 01h	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 18:30:00	4,6	13,4	13,4	13,4	13,4	13,4	17,2	17,2	18,4	Baixo	
19	Barra/Riocentro	16/01/2014 - 18:30:00	3,0	9,8	9,8	9,8	9,8	9,8	10,6	10,6	12,0	Baixo	
20	Guaratiba	16/01/2014 - 18:30:00	3,2	11,0	11,0	11,0	11,0	11,0	17,4	59,2	12,8	Baixo	
21	Est. Grajas/Jacarepaguá	16/01/2014 - 18:30:00	37,8	31,2	31,2	31,2	31,2	31,2	75,0	76,8	70,4	Alto - 01h	
22	Santa Cruz	16/01/2014 - 18:30:00	11,2	37,8	38,0	38,0	38,0	38,0	42,2	62,4	44,8	Médio - 01h	
23	Grande Méier	16/01/2014 - 18:30:00	9,2	37,0	37,0	37,0	37,0	37,0	60,0	60,0	36,8	Médio - 01h	
24	Anchieta	16/01/2014 - 18:30:00	0,4	12,8	12,8	12,8	12,8	12,8	19,2	19,2	1,6	Baixo	
25	Grota Funda	16/01/2014 - 18:30:00	13,6	15,2	15,2	15,2	15,2	15,2	16,8	24,6	54,4	Baixo	
27	Sepetiba	16/01/2014 - 18:30:00	0,8	1,2	1,2	1,2	1,2	1,2	3,2	38,8	3,2	Baixo	
28	Alto da Boa Vista	16/01/2014 - 18:30:00	33,8	35,2	35,2	35,2	35,2	35,2	39,2	51,8	31,8	Alto - 01h	
29	Av. Brasil/Mendanha	16/01/2014 - 18:30:00	11,6	16,0	16,6	16,6	16,6	16,6	17,8	20,4	46,4	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 18:30:00	5,0	6,8	6,8	6,8	6,8	6,8	8,6	8,6	20,0	Baixo	
31	Laranjeiras	16/01/2014 - 18:30:00	0,4	21,6	21,6	21,6	21,6	21,6	21,8	22,0	1,6	Baixo	
32	São Cristóvão	16/01/2014 - 18:30:00	1,4	3,4	3,4	3,4	3,4	3,4	21,4	21,4	5,6	Baixo	
33	Tijuca/Muda	16/01/2014 - 18:30:00	1,8	17,2	17,2	17,2	17,2	17,2	32,4	32,4	7,2	Baixo	

Identificação			Chuvvas										Alarmes
N. 1	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 18:45:00	13,8	37,8	37,8	37,8	37,8	37,8	37,8	37,8	33,0	Alto - 01h	
2	Urca	16/01/2014 - 18:45:00	2,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	8,0	Baixo	
3	Rosinha	16/01/2014 - 18:45:00	31,8	71,8	71,8	71,8	71,8	71,8	72,8	72,8	86,4	Alto - 01h	
4	Tijuca	16/01/2014 - 18:45:00	2,6	6,2	6,2	6,2	6,2	6,2	14,6	14,6	10,4	Baixo	
5	Santa Teresa	16/01/2014 - 18:45:00	1,0	12,8	12,8	12,8	12,8	12,8	13,2	13,4	4,0	Baixo	
6	Copacabana	16/01/2014 - 18:45:00	3,2	30,0	30,0	30,0	30,0	30,0	30,0	30,0	12,8	Médio - 01h	
7	Grajas	16/01/2014 - 18:45:00	9,8	70,0	70,0	70,0	70,0	70,0	100,0	100,0	36,0	Alto - 01h	
8	Ilha do Governador	16/01/2014 - 18:45:00	0,0	2,0	18,6	18,6	18,6	18,6	26,8	28,4	0,0	Baixo	
9	Penha	16/01/2014 - 18:45:00	1,0	22,0	22,0	22,0	22,0	22,0	38,4	39,8	4,0	Baixo	
10	Madureira	16/01/2014 - 18:45:00	37,8	34,0	34,0	34,0	34,0	34,0	74,0	74,0	110,4	Alto - 01h	
11	Irajá	16/01/2014 - 18:45:00	17,8	35,2	35,2	35,2	35,2	35,2	60,0	60,0	71,2	Alto - 01h	
12	Bangu	16/01/2014 - 18:45:00	3,8	8,6	9,2	9,2	9,2	9,2	9,2	23,6	15,2	Baixo	
13	Piedade	16/01/2014 - 18:45:00	28,8	70,8	70,8	70,8	70,8	70,8	96,8	91,0	113,0	Alto - 01h	
14	Jacarepaguá/Tanque	16/01/2014 - 18:45:00	15,4	25,8	25,8	25,8	25,8	25,8	39,4	39,4	61,6	Médio - 01h	
15	Saúde	16/01/2014 - 18:45:00	2,0	22,4	24,2	24,2	24,2	24,2	28,2	28,4	8,0	Baixo	
16	Jardim Botânico	16/01/2014 - 18:45:00	5,6	41,0	41,0	41,0	41,0	41,0	41,2	41,2	22,4	Médio - 01h	
17	Barra/Barrinha	16/01/2014 - 18:45:00	34,2	30,4	30,4	30,4	30,4	30,4	30,0	30,0	96,8	Alto - 01h	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 18:45:00	14,4	27,8	27,8	27,8	27,8	27,8	31,6	31,6	57,6	Médio - 01h	
19	Barra/Riocentro	16/01/2014 - 18:45:00	27,8	37,6	37,6	37,6	37,6	37,6	38,4	38,4	111,2	Médio - 01h	
20	Guaratiba	16/01/2014 - 18:45:00	13,0	22,0	24,0	24,0	24,0	24,0	30,4	72,2	52,0	Baixo	
21	Est. Grajas/Jacarepaguá	16/01/2014 - 18:45:00	18,8	77,8	77,8	77,8	77,8	77,8	91,8	93,8	68,4	Alto - 01h	
22	Santa Cruz	16/01/2014 - 18:45:00	2,2	40,0	40,0	40,2	40,2	40,2	44,4	64,6	8,8	Médio - 01h	
23	Grande Méier	16/01/2014 - 18:45:00	10,0	47,0	47,0	47,0	47,0	47,0	70,0	70,0	40,0	Médio - 01h	
24	Anchieta	16/01/2014 - 18:45:00	5,6	17,8	18,4	18,4	18,4	18,4	24,8	24,8	22,4	Baixo	
25	Grota Funda	16/01/2014 - 18:45:00	11,0	26,2	26,2	26,2	26,2	26,2	27,8	35,6	44,0	Médio - 01h	
26	Campo Grande	16/01/2014 - 18:45:00	6,0	33,2	34,8	34,8	34,8	34,8	34,8	58,8	0,0	Alto - 01h	
27	Sepetiba	16/01/2014 - 18:45:00	1,8	3,0	3,0	3,0	3,0	3,0	5,0	40,6	7,2	Baixo	
28	Alto da Boa Vista	16/01/2014 - 18:45:00	9,2	34,4	34,4	34,4	34,4	34,4	69,4	71,0	35,8	Alto - 01h	
29	Av. Brasil/Mendanha	16/01/2014 - 18:45:00	7,8	23,8	24,4	24,4	24,4	24,4	25,6	28,2	31,2	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 18:45:00	18,8	25,6	25,6	25,6	25,6	25,6	27,4	27,4	75,2	Médio - 01h	
31	Laranjeiras	16/01/2014 - 18:45:00	0,8	22,4	22,4	22,4	22,4	22,4	22,6	22,8	3,2	Baixo	
32	São Cristóvão	16/01/2014 - 18:45:00	4,4	7,8	7,8	7,8	7,8	7,8	25,8	25,8	17,6	Baixo	
33	Tijuca/Muda	16/01/2014 - 18:45:00	4,0	21,2	21,2	21,2	21,2	21,2	36,4	36,4	16,0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Viçigal	16/01/2014 - 19:00:00	2,2	71,0	71,0	71,0	71,0	71,0	71,0	71,0	12,8	Alto - 01h	
2	Urca	16/01/2014 - 19:00:00	3,6	16,4	26,6	26,6	26,6	26,6	26,6	26,6	14,4	Baixo	
3	Rosinha	16/01/2014 - 19:00:00	3,3	76,8	76,8	76,8	76,8	76,8	77,8	77,8	20,8	Alto - 01h	
4	Tijuca	16/01/2014 - 19:00:00	5,0	9,8	11,2	11,2	11,2	11,2	19,6	19,6	20,0	Baixo	
5	Santa Teresa	16/01/2014 - 19:00:00	3,0	9,8	15,8	15,8	15,8	15,8	16,2	16,4	12,0	Baixo	
6	Copacabana	16/01/2014 - 19:00:00	2,6	32,4	32,6	32,6	32,6	32,6	32,6	32,6	10,4	Médio - 01h	
7	Grajaú	16/01/2014 - 19:00:00	0,2	69,8	79,8	79,8	79,8	79,8	106,0	106,0	23,2	Alto - 01h	
8	Ilha do Governador	16/01/2014 - 19:00:00	0,2	0,8	18,8	18,8	18,8	18,8	18,8	27,0	28,6	0,8	Baixo
9	Penha	16/01/2014 - 19:00:00	1,0	16,2	23,0	23,0	23,0	23,0	39,4	40,8	4,0	Baixo	
10	Madureira	16/01/2014 - 19:00:00	8,8	73,4	74,2	74,2	74,2	74,2	83,8	83,8	38,4	Alto - 01h	
11	Itajá	16/01/2014 - 19:00:00	4,6	55,6	67,8	67,8	67,8	67,8	84,8	84,8	18,4	Alto - 01h	
12	Bangu	16/01/2014 - 19:00:00	2,2	9,6	11,4	11,4	11,4	11,4	11,4	25,8	8,8	Baixo	
13	Piedade	16/01/2014 - 19:00:00	3,8	70,4	76,4	76,4	76,4	76,4	86,2	87,2	23,2	Alto - 01h	
14	Jacarepaguá/Tanque	16/01/2014 - 19:00:00	16,2	40,4	42,0	42,0	42,0	42,0	55,6	55,6	64,8	Médio - 01h	
15	Saúde	16/01/2014 - 19:00:00	2,6	9,0	26,8	26,8	26,8	26,8	30,8	31,0	10,4	Baixo	
16	Jardim Botânico	16/01/2014 - 19:00:00	3,2	43,8	44,2	44,2	44,2	44,2	44,4	44,4	12,8	Médio - 01h	
17	Barra/Barrinha	16/01/2014 - 19:00:00	12,8	63,0	63,8	63,8	63,8	63,8	63,4	63,4	30,4	Alto - 01h	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 19:00:00	15,6	38,4	43,4	43,4	43,4	43,4	47,2	47,2	62,4	Médio - 01h	
19	Barra/Riocentro	16/01/2014 - 19:00:00	16,8	63,8	64,4	64,4	64,4	64,4	65,2	65,2	107,2	Alto - 01h	
20	Guaratiba	16/01/2014 - 19:00:00	2,2	23,2	26,2	26,2	26,2	26,2	32,6	74,4	8,8	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 19:00:00	10,6	73,4	88,4	88,4	88,4	88,4	102,2	104,8	41,4	Alto - 01h	
22	Santa Cruz	16/01/2014 - 19:00:00	1,4	40,4	41,4	41,4	41,4	41,4	45,8	66,0	5,6	Médio - 01h	
23	Grande Méier	16/01/2014 - 19:00:00	2,8	47,2	49,8	49,8	49,8	49,8	72,8	72,8	11,2	Médio - 01h	
24	Anchieta	16/01/2014 - 19:00:00	2,6	12,4	21,0	21,0	21,0	21,0	27,4	27,4	10,4	Baixo	
25	Grota Funda	16/01/2014 - 19:00:00	10,4	36,6	36,6	36,6	36,6	36,6	38,2	46,0	41,6	Médio - 01h	
26	Campo Grande	16/01/2014 - 19:00:00	3,4	32,6	37,4	37,4	37,4	37,4	37,4	61,8	11,4	Alto - 01h	
27	Sepetiba	16/01/2014 - 19:00:00	0,4	3,0	3,4	3,4	3,4	3,4	5,4	41,0	1,6	Baixo	
28	Alto da Boa Vista	16/01/2014 - 19:00:00	6,2	69,8	72,8	72,8	72,8	72,8	74,2	77,2	24,2	Alto - 01h	
29	Av. Brasil/Mendanha	16/01/2014 - 19:00:00	4,2	28,0	28,2	28,6	28,6	28,6	29,8	32,4	16,8	Médio - 01h	
30	Recreio dos Bandeirantes	16/01/2014 - 19:00:00	8,4	33,8	34,0	34,0	34,0	34,0	35,8	35,8	33,6	Médio - 01h	
31	Laranjeiras	16/01/2014 - 19:00:00	0,8	11,4	23,2	23,2	23,2	23,2	23,4	23,6	3,2	Baixo	
32	São Cristóvão	16/01/2014 - 19:00:00	5,2	11,4	13,0	13,0	13,0	13,0	31,0	31,0	20,8	Baixo	
33	Tijuca/Muda	16/01/2014 - 19:00:00	6,8	23,8	28,0	28,0	28,0	28,0	43,2	43,2	27,2	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Viçigal	16/01/2014 - 19:15:00	2,8	67,4	69,4	73,4	73,4	73,4	73,4	73,4	9,6	Alto - 01h	
2	Urca	16/01/2014 - 19:15:00	0,8	7,6	27,4	27,4	27,4	27,4	27,4	27,4	3,2	Baixo	
3	Rosinha	16/01/2014 - 19:15:00	2,6	66,0	69,4	69,4	69,4	69,4	81,2	81,2	14,4	Alto - 01h	
4	Tijuca	16/01/2014 - 19:15:00	0,6	8,6	11,8	11,8	11,8	11,8	20,2	20,2	2,4	Baixo	
5	Santa Teresa	16/01/2014 - 19:15:00	0,6	5,0	16,4	16,4	16,4	16,4	16,8	17,0	2,4	Baixo	
6	Copacabana	16/01/2014 - 19:15:00	1,6	15,8	34,2	34,2	34,2	34,2	34,2	34,2	6,4	Baixo	
7	Grajaú	16/01/2014 - 19:15:00	0,2	35,8	76,0	76,0	76,0	76,0	106,2	106,2	0,8	Médio - 01h	
8	Ilha do Governador	16/01/2014 - 19:15:00	0,0	0,4	18,8	18,8	18,8	18,8	27,0	28,6	0,0	Baixo	
9	Penha	16/01/2014 - 19:15:00	0,4	6,4	23,4	23,4	23,4	23,4	39,8	41,2	1,6	Baixo	
10	Madureira	16/01/2014 - 19:15:00	2,8	27,8	75,8	75,8	75,8	75,8	85,2	85,2	5,6	Alto - 01h	
11	Itajá	16/01/2014 - 19:15:00	0,6	40,0	68,4	68,4	68,4	68,4	85,4	85,4	2,4	Médio - 01h	
12	Bangu	16/01/2014 - 19:15:00	0,4	10,0	11,8	11,8	11,8	11,8	11,8	26,2	1,6	Baixo	
13	Piedade	16/01/2014 - 19:15:00	1,4	34,8	37,8	37,8	37,8	37,8	86,2	86,2	5,6	Alto - 01h	
14	Jacarepaguá/Tanque	16/01/2014 - 19:15:00	3,8	41,6	45,8	45,8	45,8	45,8	59,4	59,4	15,2	Médio - 01h	
15	Saúde	16/01/2014 - 19:15:00	0,2	5,6	27,0	27,0	27,0	27,0	31,0	31,2	0,8	Baixo	
16	Jardim Botânico	16/01/2014 - 19:15:00	2,2	27,4	46,4	46,4	46,4	46,4	46,6	46,6	8,8	Médio - 01h	
17	Barra/Barrinha	16/01/2014 - 19:15:00	2,8	59,6	65,4	65,4	65,4	65,4	65,8	65,8	5,6	Alto - 01h	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 19:15:00	4,8	39,4	48,2	48,2	48,2	48,2	52,0	52,0	19,2	Médio - 01h	
19	Barra/Riocentro	16/01/2014 - 19:15:00	3,8	61,2	68,0	68,0	68,0	68,0	68,8	68,8	14,4	Alto - 01h	
20	Guaratiba	16/01/2014 - 19:15:00	2,4	20,8	28,6	28,6	28,6	28,6	35,0	76,8	9,6	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 19:15:00	2,6	47,4	91,0	91,0	91,0	91,0	104,8	106,6	10,4	Médio - 24h	
22	Santa Cruz	16/01/2014 - 19:15:00	1,2	16,0	42,6	42,8	42,8	42,8	47,0	67,2	4,8	Baixo	
23	Grande Méier	16/01/2014 - 19:15:00	0,4	22,4	50,2	50,2	50,2	50,2	73,2	73,2	1,6	Baixo	
24	Anchieta	16/01/2014 - 19:15:00	1,2	9,8	22,2	22,2	22,2	22,2	28,6	28,6	4,8	Baixo	
25	Grota Funda	16/01/2014 - 19:15:00	1,8	36,8	38,4	38,4	38,4	38,4	40,0	47,8	7,2	Médio - 01h	
26	Campo Grande	16/01/2014 - 19:15:00	1,6	45,2	59,0	59,0	59,0	59,0	59,0	63,4	6,4	Médio - 01h	
27	Sepetiba	16/01/2014 - 19:15:00	0,6	3,6	4,0	4,0	4,0	4,0	6,0	41,6	2,4	Baixo	
28	Alto da Boa Vista	16/01/2014 - 19:15:00	0,8	39,6	71,4	71,4	71,4	71,4	75,4	78,0	3,2	Médio - 01h	
29	Av. Brasil/Mendanha	16/01/2014 - 19:15:00	1,0	24,6	29,0	29,6	29,6	29,6	30,8	33,4	4,0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 19:15:00	3,0	35,2	37,0	37,0	37,0	37,0	38,8	38,8	12,0	Médio - 01h	
31	Laranjeiras	16/01/2014 - 19:15:00	1,2	3,2	24,4	24,4	24,4	24,4	24,6	24,8	4,8	Baixo	
32	São Cristóvão	16/01/2014 - 19:15:00	0,4	11,4	13,4	13,4	13,4	13,4	31,4	31,4	1,6	Baixo	
33	Tijuca/Muda	16/01/2014 - 19:15:00	0,4	13,0	28,4	ND	28,4	28,4	43,6	43,6	1,6	Baixo	

Identificação			Chuvvas										Alarmes
N. 1	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 19:30:00	1,4	20,0	74,8	74,8	74,8	74,8	74,8	74,8	5,6	Baixo	
2	Urca	16/01/2014 - 19:30:00	0,6	7,0	28,0	28,0	28,0	28,0	28,0	28,0	2,4	Baixo	
3	Rocinha	16/01/2014 - 19:30:00	1,0	31,2	81,4	81,4	81,4	81,4	82,2	82,2	4,0	Médio - 01h	
4	Tijuca	16/01/2014 - 19:30:00	0,0	8,2	11,8	11,8	11,8	11,8	20,2	20,2	0,0	Baixo	
5	Santa Teresa	16/01/2014 - 19:30:00	0,0	4,6	16,4	16,4	16,4	16,4	16,8	17,0	0,0	Baixo	
6	Copacabana	16/01/2014 - 19:30:00	0,6	8,0	34,8	34,8	34,8	34,8	34,8	34,8	2,4	Baixo	
7	Grajaú	16/01/2014 - 19:30:00	0,0	15,0	76,0	76,0	76,0	76,0	106,2	106,2	0,0	Baixo	
8	Ilha do Governador	16/01/2014 - 19:30:00	0,0	0,2	9,8	18,8	18,8	18,8	27,0	28,6	0,0	Baixo	
9	Penha	16/01/2014 - 19:30:00	0,0	2,4	23,4	23,4	23,4	23,4	39,8	41,2	0,0	Baixo	
10	Madureira	16/01/2014 - 19:30:00	0,2	38,8	75,8	75,8	75,8	75,8	85,2	85,2	0,8	Médio - 01h	
11	Irajá	16/01/2014 - 19:30:00	0,0	23,0	68,4	68,4	68,4	68,4	85,4	85,4	0,0	Baixo	
12	Bangu	16/01/2014 - 19:30:00	0,4	6,8	12,0	12,2	12,2	12,2	12,2	26,6	1,6	Baixo	
13	Piedade	16/01/2014 - 19:30:00	0,2	35,4	78,0	78,0	78,0	78,0	98,2	98,6	0,8	Médio - 01h	
14	Jacarepaguá/Tanque	16/01/2014 - 19:30:00	0,4	35,8	46,2	46,2	46,2	46,2	59,8	59,8	1,6	Médio - 01h	
15	Saúde	16/01/2014 - 19:30:00	0,0	4,8	27,0	27,0	27,0	27,0	31,0	31,2	0,0	Baixo	
16	Jardim Botânico	16/01/2014 - 19:30:00	0,4	11,4	46,8	46,8	46,8	46,8	47,0	47,0	1,6	Baixo	
17	Barra/Barrinha	16/01/2014 - 19:30:00	0,8	40,0	66,2	66,2	66,2	66,2	66,6	66,6	3,2	Médio - 01h	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 19:30:00	0,6	35,4	48,8	48,8	48,8	48,8	52,6	52,6	2,4	Médio - 01h	
19	Barra/Riocentro	16/01/2014 - 19:30:00	0,8	59,8	88,4	88,4	88,4	88,4	89,2	89,2	1,6	Alto - 01h	
20	Guaratiba	16/01/2014 - 19:30:00	0,8	18,4	29,4	29,4	29,4	29,4	35,8	77,6	3,2	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 19:30:00	0,2	30,0	91,2	91,2	91,2	91,2	105,0	106,8	0,8	Médio - 24h	
22	Santa Cruz	16/01/2014 - 19:30:00	0,8	5,6	43,4	43,6	43,6	43,6	47,8	68,0	3,2	Baixo	
23	Grande Méier	16/01/2014 - 19:30:00	0,2	13,4	50,4	50,4	50,4	50,4	73,4	73,4	0,8	Baixo	
24	Anchieta	16/01/2014 - 19:30:00	0,4	9,8	22,6	22,6	22,6	22,6	29,0	29,0	1,6	Baixo	
25	Grota Funda	16/01/2014 - 19:30:00	0,4	23,6	38,8	38,8	38,8	38,8	40,4	48,2	1,6	Baixo	
26	Campo Grande	16/01/2014 - 19:30:00	0,8	ND	59,8	59,8	59,8	59,8	59,8	64,2	3,2		
27	Sepetiba	16/01/2014 - 19:30:00	0,8	3,6	4,8	4,8	4,8	4,8	6,8	42,4	3,2	Baixo	
28	Alto da Boa Vista	16/01/2014 - 19:30:00	0,4	16,6	71,8	71,8	71,8	71,8	75,8	78,4	1,6	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 19:30:00	0,6	13,6	29,6	30,2	30,2	30,2	31,4	34,0	2,4	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 19:30:00	0,4	30,6	37,4	37,4	37,4	37,4	39,2	39,2	1,6	Médio - 01h	
31	Laranjeiras	16/01/2014 - 19:30:00	0,6	3,4	25,0	25,0	25,0	25,0	25,2	25,4	2,4	Baixo	
32	São Cristóvão	16/01/2014 - 19:30:00	0,0	10,0	13,4	13,4	13,4	13,4	31,4	31,4	0,0	Baixo	
33	Tijuca/Muda	16/01/2014 - 19:30:00	0,0	11,2	28,4	28,4	28,4	28,4	43,6	43,6	0,0	Baixo	

Identificação			Chuvvas										Alarmes
N. 1	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 19:45:00	0,2	7,2	75,0	75,0	75,0	75,0	75,0	75,0	0,8	Baixo	
2	Urca	16/01/2014 - 19:45:00	0,2	5,2	28,2	28,2	28,2	28,2	28,2	28,2	0,8	Baixo	
3	Rocinha	16/01/2014 - 19:45:00	0,6	10,2	82,0	82,0	82,0	82,0	82,8	82,8	2,4	Baixo	
4	Tijuca	16/01/2014 - 19:45:00	0,2	5,8	12,0	12,0	12,0	12,0	20,4	20,4	0,8	Baixo	
5	Santa Teresa	16/01/2014 - 19:45:00	0,4	4,0	16,8	16,8	16,8	16,8	17,2	17,4	1,6	Baixo	
6	Copacabana	16/01/2014 - 19:45:00	0,2	5,0	35,0	35,0	35,0	35,0	35,0	35,0	0,8	Baixo	
7	Grajaú	16/01/2014 - 19:45:00	0,0	6,0	76,0	76,0	76,0	76,0	106,2	106,2	0,0	Baixo	
8	Ilha do Governador	16/01/2014 - 19:45:00	0,6	0,8	2,8	19,4	19,4	19,4	27,6	29,2	2,4	Baixo	
9	Penha	16/01/2014 - 19:45:00	0,8	2,2	24,2	24,2	24,2	24,2	40,6	42,0	3,2	Baixo	
10	Madureira	16/01/2014 - 19:45:00	0,2	11,4	76,0	76,0	76,0	76,0	85,4	85,4	0,8	Baixo	
11	Irajá	16/01/2014 - 19:45:00	0,4	5,6	68,8	68,8	68,8	68,8	85,8	85,8	1,6	Baixo	
12	Bangu	16/01/2014 - 19:45:00	0,4	3,4	12,0	12,6	12,6	12,6	12,6	27,0	1,6	Baixo	
13	Piedade	16/01/2014 - 19:45:00	0,2	7,6	78,2	78,2	78,2	78,2	98,4	98,8	0,8	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 19:45:00	0,2	20,6	46,4	46,4	46,4	46,4	60,0	60,0	0,8	Baixo	
15	Saúde	16/01/2014 - 19:45:00	0,4	3,2	25,6	27,4	27,4	27,4	31,4	31,6	1,6	Baixo	
16	Jardim Botânico	16/01/2014 - 19:45:00	0,0	5,8	46,8	46,8	46,8	46,8	47,0	47,0	0,0	Baixo	
17	Barra/Barrinha	16/01/2014 - 19:45:00	0,2	16,0	66,4	66,4	66,4	66,4	66,8	66,8	0,8	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 19:45:00	0,2	21,2	49,0	49,0	49,0	49,0	52,8	52,8	0,8	Baixo	
19	Barra/Riocentro	16/01/2014 - 19:45:00	0,2	31,0	68,6	68,6	68,6	68,6	69,4	69,4	0,8	Médio - 01h	
20	Guaratiba	16/01/2014 - 19:45:00	0,6	6,0	28,0	30,0	30,0	30,0	36,4	78,2	2,4	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 19:45:00	0,0	13,4	91,2	91,2	91,2	91,2	105,0	106,8	0,0	Médio - 24h	
22	Santa Cruz	16/01/2014 - 19:45:00	1,8	5,2	45,2	45,2	45,4	45,4	49,6	69,8	7,2	Baixo	
23	Grande Méier	16/01/2014 - 19:45:00	0,2	3,6	50,6	50,6	50,6	50,6	73,6	73,6	0,8	Baixo	
24	Anchieta	16/01/2014 - 19:45:00	0,2	4,4	22,2	22,8	22,8	22,8	29,2	29,2	0,8	Baixo	
25	Grota Funda	16/01/2014 - 19:45:00	0,6	13,2	39,4	39,4	39,4	39,4	41,0	48,8	2,4	Baixo	
26	Campo Grande	16/01/2014 - 19:45:00	0,6	6,0	59,2	60,4	60,4	60,4	60,4	64,8	2,4	Baixo	
27	Sepetiba	16/01/2014 - 19:45:00	1,2	3,0	6,0	6,0	6,0	6,0	8,0	43,6	4,8	Baixo	
28	Alto da Boa Vista	16/01/2014 - 19:45:00	0,2	7,6	72,0	72,0	72,0	72,0	76,0	78,6	0,8	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 19:45:00	1,2	7,0	30,8	31,4	31,4	31,4	32,6	35,2	4,8	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 19:45:00	0,4	12,2	37,8	37,8	37,8	37,8	39,6	39,6	1,6	Baixo	
31	Laranjeiras	16/01/2014 - 19:45:00	0,4	3,0	25,4	25,4	25,4	25,4	25,6	25,8	1,6	Baixo	
32	São Cristóvão	16/01/2014 - 19:45:00	0,4	6,0	13,8	13,8	13,8	13,8	31,8	31,8	1,6	Baixo	
33	Tijuca/Muda	16/01/2014 - 19:45:00	0,2	7,4	28,6	28,6	28,6	28,6	43,8	43,8	0,8	Baixo	

Identificação			Chuvvas										Alarmes
N. 1 A	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escoregame...	
1	Vidigal	16/01/2014 - 20:00:00	0.2	4.2	75.2	75.2	75.2	75.2	75.2	75.2	0.8	Baixo	
2	Urca	16/01/2014 - 20:00:00	0.2	1.8	18.2	28.4	28.4	28.4	28.4	28.4	0.8	Baixo	
3	Rocinha	16/01/2014 - 20:00:00	0.2	5.4	82.2	82.2	82.2	82.2	83.0	83.0	0.8	Baixo	
4	Tijuca	16/01/2014 - 20:00:00	0.2	1.0	10.8	12.2	12.2	12.2	20.6	20.6	0.8	Baixo	
5	Santa Teresa	16/01/2014 - 20:00:00	0.2	1.2	11.0	17.0	17.0	17.0	17.4	17.6	0.8	Baixo	
6	Copacabana	16/01/2014 - 20:00:00	0.2	2.6	35.0	35.2	35.2	35.2	35.2	35.2	0.8	Baixo	
7	Grajaú	16/01/2014 - 20:00:00	0.2	0.4	70.2	76.2	76.2	76.2	106.4	106.4	0.8	Baixo	
8	Ilha do Governador	16/01/2014 - 20:00:00	0.8	1.4	2.2	20.2	20.2	20.2	28.4	30.0	3.2	Baixo	
9	Penha	16/01/2014 - 20:00:00	0.6	1.8	18.0	24.8	24.8	24.8	41.2	42.6	2.4	Baixo	
10	Madureira	16/01/2014 - 20:00:00	0.6	2.4	76.0	76.6	76.6	76.6	86.0	86.0	2.4	Baixo	
11	Irajá	16/01/2014 - 20:00:00	0.8	1.8	60.4	69.6	69.6	69.6	86.6	86.6	3.2	Baixo	
12	Bangu	16/01/2014 - 20:00:00	0.4	1.6	11.2	13.0	13.0	13.0	13.0	27.4	1.6	Baixo	
13	Piedade	16/01/2014 - 20:00:00	0.4	2.2	72.6	78.6	78.6	78.6	98.8	99.2	1.6	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 20:00:00	0.4	4.8	45.2	46.8	46.8	46.8	60.4	60.4	1.6	Baixo	
15	Saúde	16/01/2014 - 20:00:00	0.4	1.0	10.0	27.8	27.8	27.8	31.8	32.0	1.6	Baixo	
16	Jardim Botânico	16/01/2014 - 20:00:00	0.2	2.8	46.6	47.0	47.0	47.0	47.2	47.2	0.8	Baixo	
17	Barra/Barrinha	16/01/2014 - 20:00:00	0.2	3.6	66.6	66.6	66.6	66.6	67.0	67.0	0.8	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 20:00:00	0.2	5.8	44.2	49.2	49.2	49.2	53.0	53.0	0.8	Baixo	
19	Barra/Riocentro	16/01/2014 - 20:00:00	0.4	4.6	68.4	69.0	69.0	69.0	69.8	69.8	1.6	Baixo	
20	Guaratiba	16/01/2014 - 20:00:00	0.6	4.4	27.6	30.6	30.6	30.6	37.0	78.8	2.4	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 20:00:00	0.4	3.2	76.6	91.6	91.6	91.6	105.4	107.2	1.6	Mélio - 24h	
22	Santa Cruz	16/01/2014 - 20:00:00	0.8	4.6	45.0	46.0	46.2	46.2	50.4	70.6	3.2	Baixo	
23	Grande Méier	16/01/2014 - 20:00:00	0.4	1.2	48.4	51.0	51.0	51.0	74.0	74.0	1.6	Baixo	
24	Anchieta	16/01/2014 - 20:00:00	0.6	2.4	14.8	23.4	23.4	23.4	29.8	29.8	2.4	Baixo	
25	Grota Funda	16/01/2014 - 20:00:00	0.6	3.4	40.0	40.0	40.0	40.0	41.6	49.4	2.4	Baixo	
26	Campo Grande	16/01/2014 - 20:00:00	0.6	3.6	59.2	61.0	61.0	61.0	61.0	65.4	2.4	Baixo	
27	Sepetiba	16/01/2014 - 20:00:00	1.0	3.6	6.6	7.0	7.0	7.0	9.0	44.6	4.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 20:00:00	0.4	1.8	71.6	72.4	72.4	72.4	76.4	79.0	1.6	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 20:00:00	1.2	4.0	32.0	32.2	32.6	32.6	33.8	36.4	4.8	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 20:00:00	0.4	4.2	38.0	38.2	38.2	38.2	40.0	40.0	1.6	Baixo	
31	Laranjeiras	16/01/2014 - 20:00:00	0.4	2.6	14.0	25.8	25.8	25.8	26.0	26.2	1.6	Baixo	
32	São Cristóvão	16/01/2014 - 20:00:00	0.2	1.0	12.4	14.0	14.0	14.0	32.0	32.0	0.8	Baixo	
33	Tijuca/Muda	16/01/2014 - 20:00:00	0.0	0.6	24.4	28.6	28.6	28.6	43.8	43.8	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N. 1 A	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escoregame...	
1	Vidigal	16/01/2014 - 20:15:00	0.6	2.4	60.0	75.8	75.8	75.8	75.8	75.8	2.4	Baixo	
2	Urca	16/01/2014 - 20:15:00	0.4	1.4	9.0	28.8	28.8	28.8	28.8	28.8	1.6	Baixo	
3	Rocinha	16/01/2014 - 20:15:00	0.6	2.4	66.4	82.8	82.8	82.8	83.6	83.6	2.4	Baixo	
4	Tijuca	16/01/2014 - 20:15:00	0.8	1.2	9.8	13.0	13.0	13.0	21.4	21.4	3.2	Baixo	
5	Santa Teresa	16/01/2014 - 20:15:00	0.8	1.4	6.4	17.8	17.8	17.8	18.2	18.4	3.2	Baixo	
6	Copacabana	16/01/2014 - 20:15:00	0.2	1.2	17.0	35.4	35.4	35.4	35.4	35.4	0.8	Baixo	
7	Grajaú	16/01/2014 - 20:15:00	0.8	1.0	36.8	77.0	77.0	77.0	107.2	107.2	3.2	Baixo	
8	Ilha do Governador	16/01/2014 - 20:15:00	1.0	2.4	2.8	21.2	21.2	21.2	29.4	31.0	4.0	Baixo	
9	Penha	16/01/2014 - 20:15:00	1.0	2.4	8.8	25.8	25.8	25.8	42.2	43.6	4.0	Baixo	
10	Madureira	16/01/2014 - 20:15:00	1.2	2.2	60.0	77.8	77.8	77.8	87.2	87.2	4.8	Baixo	
11	Irajá	16/01/2014 - 20:15:00	0.8	2.0	42.0	70.4	70.4	70.4	87.4	87.4	3.2	Baixo	
12	Bangu	16/01/2014 - 20:15:00	0.6	1.8	11.8	13.6	13.6	13.6	13.6	28.0	2.4	Baixo	
13	Piedade	16/01/2014 - 20:15:00	0.8	1.6	55.6	79.4	79.4	79.4	99.6	100.0	3.2	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 20:15:00	1.0	2.0	43.6	47.8	47.8	47.8	61.4	61.4	4.0	Baixo	
15	Saúde	16/01/2014 - 20:15:00	0.4	1.2	6.8	28.2	28.2	28.2	32.2	32.4	1.6	Baixo	
16	Jardim Botânico	16/01/2014 - 20:15:00	0.6	1.2	28.6	47.6	47.6	47.6	47.8	47.8	2.4	Baixo	
17	Barra/Barrinha	16/01/2014 - 20:15:00	0.6	1.8	61.4	67.2	67.2	67.2	67.6	67.6	2.4	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 20:15:00	0.8	1.8	41.2	50.0	50.0	50.0	53.8	53.8	3.2	Baixo	
19	Barra/Riocentro	16/01/2014 - 20:15:00	1.0	2.0	63.2	70.0	70.0	70.0	70.8	70.8	4.0	Baixo	
20	Guaratiba	16/01/2014 - 20:15:00	0.8	2.8	23.6	31.4	31.4	31.4	37.8	79.6	3.2	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 20:15:00	0.8	1.4	48.8	92.4	92.4	92.4	106.2	108.0	3.2	Mélio - 24h	
22	Santa Cruz	16/01/2014 - 20:15:00	1.2	4.6	20.6	47.2	47.4	47.4	51.6	71.8	4.8	Baixo	
23	Grande Méier	16/01/2014 - 20:15:00	0.6	1.4	23.8	51.6	51.6	51.6	74.6	74.6	2.4	Baixo	
24	Anchieta	16/01/2014 - 20:15:00	0.8	2.0	11.8	24.2	24.2	24.2	30.6	30.6	3.2	Baixo	
25	Grota Funda	16/01/2014 - 20:15:00	0.6	2.2	39.0	40.6	40.6	40.6	42.2	50.0	2.4	Baixo	
26	Campo Grande	16/01/2014 - 20:15:00	1.4	3.4	48.6	62.4	62.4	62.4	62.4	66.8	5.6	Baixo	
27	Sepetiba	16/01/2014 - 20:15:00	0.8	3.8	7.4	7.8	7.8	7.8	9.8	45.4	3.2	Baixo	
28	Alto da Boa Vista	16/01/2014 - 20:15:00	0.8	1.8	41.4	73.2	73.2	73.2	77.2	79.8	3.2	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 20:15:00	1.0	4.0	28.6	33.0	33.6	33.6	34.8	37.4	4.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 20:15:00	0.6	1.8	37.0	38.8	38.8	38.8	40.6	40.6	2.4	Baixo	
31	Laranjeiras	16/01/2014 - 20:15:00	0.6	2.0	5.2	26.4	26.4	26.4	26.6	26.8	2.4	Baixo	
32	São Cristóvão	16/01/2014 - 20:15:00	0.6	1.2	12.6	14.6	14.6	14.6	32.6	32.6	2.4	Baixo	
33	Tijuca/Muda	16/01/2014 - 20:15:00	1.0	1.2	14.2	29.6	ND	29.6	44.8	44.8	4.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 22:45:00	0.0	0.6	3.4	5.8	13.0	80.8	80.8	80.8	0.0	Baixo	
2	Urca	16/01/2014 - 22:45:00	0.0	0.8	4.0	6.4	11.6	34.6	34.6	34.6	0.0	Baixo	
3	Rocinha	16/01/2014 - 22:45:00	0.0	0.6	3.6	6.2	16.4	88.2	89.0	89.0	0.0	Méio - 24h	
4	Tijuca	16/01/2014 - 22:45:00	0.2	0.8	4.2	7.4	13.2	19.4	27.8	27.8	0.8	Baixo	
5	Santa Teresa	16/01/2014 - 22:45:00	0.0	0.4	3.8	7.4	11.4	24.2	24.6	24.8	0.0	Baixo	
6	Copacabana	16/01/2014 - 22:45:00	0.2	1.2	4.8	7.0	12.0	42.0	42.0	42.0	0.8	Baixo	
7	Grajaú	16/01/2014 - 22:45:00	0.0	0.6	4.2	7.6	13.6	83.6	113.8	113.8	0.0	Baixo	
8	Ilha do Governador	16/01/2014 - 22:45:00	0.0	0.2	2.6	5.8	6.6	25.2	33.4	35.0	0.0	Baixo	
9	Penha	16/01/2014 - 22:45:00	0.0	0.6	3.4	6.4	8.6	30.6	47.0	48.4	0.0	Baixo	
10	Madureira	16/01/2014 - 22:45:00	0.0	0.4	2.8	6.4	17.8	82.4	91.8	91.8	0.0	Baixo	
11	Irajá	16/01/2014 - 22:45:00	0.0	0.4	2.8	5.8	11.4	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	16/01/2014 - 22:45:00	0.0	0.4	3.6	6.4	9.8	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	16/01/2014 - 22:45:00	0.0	0.6	3.4	6.4	14.0	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 22:45:00	0.2	0.8	4.0	7.8	28.4	54.2	67.8	67.8	0.8	Baixo	
15	Saúde	16/01/2014 - 22:45:00	0.2	0.4	3.2	5.8	9.0	33.2	37.2	37.4	0.8	Baixo	
16	Jardim Botânico	16/01/2014 - 22:45:00	0.0	0.6	4.2	6.8	12.6	53.6	53.8	53.8	0.0	Baixo	
17	Barra/Barrinha	16/01/2014 - 22:45:00	0.0	0.8	4.0	7.0	23.0	73.4	73.8	73.8	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 22:45:00	0.2	0.6	3.2	6.2	27.4	55.2	59.0	59.0	0.8	Baixo	
19	Barra/Riocentro	16/01/2014 - 22:45:00	0.0	1.0	4.8	8.6	39.6	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	16/01/2014 - 22:45:00	0.0	0.6	4.2	7.2	13.2	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 22:45:00	0.0	0.6	3.6	7.0	20.4	98.2	112.0	113.8	0.0	Méio - 24h	
22	Santa Cruz	16/01/2014 - 22:45:00	0.0	0.0	2.6	6.8	12.0	52.2	56.4	76.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 22:45:00	0.0	0.6	3.8	6.6	10.2	57.2	80.2	80.2	0.0	Baixo	
24	Anchieta	16/01/2014 - 22:45:00	0.0	0.4	3.0	5.8	10.2	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	16/01/2014 - 22:45:00	0.0	0.4	4.4	7.2	20.4	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	16/01/2014 - 22:45:00	0.0	0.4	3.2	7.2	13.2	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	16/01/2014 - 22:45:00	0.0	0.2	2.2	5.8	8.8	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 22:45:00	0.0	0.8	4.4	8.0	15.6	80.0	84.0	86.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 22:45:00	0.0	0.2	3.6	8.2	15.2	39.6	40.8	43.4	0.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 22:45:00	0.0	0.8	4.8	7.8	20.0	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 22:45:00	0.0	0.6	3.8	6.8	9.8	32.2	32.4	32.6	0.0	Baixo	
32	São Cristóvão	16/01/2014 - 22:45:00	0.2	0.6	3.6	6.4	12.4	20.2	38.2	38.2	0.8	Baixo	
33	Tijuca/Muda	16/01/2014 - 22:45:00	0.0	0.6	3.6	6.6	14.0	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 23:00:00	0.0	0.4	2.6	5.6	9.8	80.8	80.8	80.8	0.0	Baixo	
2	Urca	16/01/2014 - 23:00:00	0.0	0.4	3.0	6.2	8.0	34.6	34.6	34.6	0.0	Baixo	
3	Rocinha	16/01/2014 - 23:00:00	0.0	0.4	2.6	6.0	11.4	88.2	89.0	89.0	0.0	Méio - 24h	
4	Tijuca	16/01/2014 - 23:00:00	0.0	0.4	3.2	7.2	8.2	19.4	27.8	27.8	0.0	Baixo	
5	Santa Teresa	16/01/2014 - 23:00:00	0.0	0.2	2.8	7.2	8.4	24.2	24.6	24.8	0.0	Baixo	
6	Copacabana	16/01/2014 - 23:00:00	0.0	0.6	3.6	6.8	9.4	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	16/01/2014 - 23:00:00	0.0	0.4	2.8	7.4	7.8	83.6	113.8	113.8	0.0	Baixo	
8	Ilha do Governador	16/01/2014 - 23:00:00	0.2	0.2	2.0	5.2	6.6	25.4	33.6	35.2	0.8	Baixo	
9	Penha	16/01/2014 - 23:00:00	0.0	0.4	2.6	5.8	7.6	30.6	47.0	48.4	0.0	Baixo	
10	Madureira	16/01/2014 - 23:00:00	0.0	0.2	2.0	5.8	8.2	82.4	91.8	91.8	0.0	Baixo	
11	Irajá	16/01/2014 - 23:00:00	0.0	0.2	2.2	5.0	6.8	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	16/01/2014 - 23:00:00	0.0	0.2	2.8	6.0	7.6	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	16/01/2014 - 23:00:00	0.0	0.4	2.2	6.0	8.2	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 23:00:00	0.0	0.4	3.0	7.4	12.2	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	16/01/2014 - 23:00:00	0.0	0.4	2.4	5.4	6.4	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	16/01/2014 - 23:00:00	0.0	0.4	3.0	6.6	9.4	53.6	53.8	53.8	0.0	Baixo	
17	Barra/Barrinha	16/01/2014 - 23:00:00	0.2	0.6	3.0	7.0	10.6	73.6	74.0	74.0	0.8	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 23:00:00	0.0	0.4	2.2	6.0	11.8	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	16/01/2014 - 23:00:00	0.0	0.4	3.4	8.2	12.8	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	16/01/2014 - 23:00:00	0.0	0.4	3.4	6.6	11.0	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 23:00:00	0.0	0.4	2.2	6.6	9.8	98.2	112.0	113.8	0.0	Méio - 24h	
22	Santa Cruz	16/01/2014 - 23:00:00	0.0	0.0	1.4	6.0	10.6	52.2	56.4	76.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 23:00:00	0.2	0.6	3.0	6.4	7.6	57.4	80.4	80.4	0.8	Baixo	
24	Anchieta	16/01/2014 - 23:00:00	0.0	0.0	2.2	5.2	7.6	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	16/01/2014 - 23:00:00	0.0	0.2	3.2	6.6	10.0	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	16/01/2014 - 23:00:00	0.0	0.2	2.4	6.6	10.2	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	16/01/2014 - 23:00:00	0.0	0.2	1.2	4.8	8.4	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 23:00:00	0.0	0.4	3.0	7.6	9.4	80.0	84.0	86.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 23:00:00	0.0	0.0	2.6	7.0	11.0	39.6	40.8	43.4	0.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 23:00:00	0.0	0.4	3.4	7.4	11.6	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 23:00:00	0.2	0.4	3.0	6.6	9.2	32.4	32.6	32.8	0.8	Baixo	
32	São Cristóvão	16/01/2014 - 23:00:00	0.0	0.4	2.6	6.2	7.2	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	16/01/2014 - 23:00:00	0.0	0.4	2.6	6.6	7.2	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 23:15:00	0.0	0.2	1.8	5.0	7.4	80.8	80.8	80.8	0.0	Baixo	
2	Úrca	16/01/2014 - 23:15:00	0.0	0.2	2.2	5.8	7.2	34.6	34.6	34.6	0.0	Baixo	
3	Rocinha	16/01/2014 - 23:15:00	0.2	0.4	2.2	5.6	8.0	88.4	89.2	89.2	0.8	Médio - 24h	
4	Tijuca	16/01/2014 - 23:15:00	0.0	0.4	2.4	6.4	7.6	19.4	27.8	27.8	0.0	Baixo	
5	Santa Teresa	16/01/2014 - 23:15:00	0.0	0.2	2.0	6.4	7.8	24.2	24.6	24.6	0.0	Baixo	
6	Copacabana	16/01/2014 - 23:15:00	0.0	0.4	2.6	6.6	7.8	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	16/01/2014 - 23:15:00	0.2	0.4	2.0	6.8	7.8	83.8	114.0	114.0	0.8	Baixo	
8	Ilha do Governador	16/01/2014 - 23:15:00	0.0	0.2	1.4	4.2	6.6	25.4	33.6	35.2	0.0	Baixo	
9	Penha	16/01/2014 - 23:15:00	0.0	0.2	1.6	4.8	7.2	30.6	47.0	48.4	0.0	Baixo	
10	Madureira	16/01/2014 - 23:15:00	0.0	0.0	1.4	4.6	6.8	82.4	91.8	91.8	0.0	Baixo	
11	Itrajá	16/01/2014 - 23:15:00	0.0	0.2	1.6	4.2	6.2	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	16/01/2014 - 23:15:00	0.0	0.0	2.0	5.4	7.2	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	16/01/2014 - 23:15:00	0.0	0.2	1.4	5.2	6.8	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 23:15:00	0.0	0.2	2.0	6.4	8.4	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	16/01/2014 - 23:15:00	0.0	0.2	1.6	5.0	6.2	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	16/01/2014 - 23:15:00	0.2	0.4	2.4	6.2	7.4	53.8	54.0	54.0	0.8	Baixo	
17	Barra/Barrinha	16/01/2014 - 23:15:00	0.0	0.4	2.0	6.4	8.2	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 23:15:00	0.0	0.2	1.4	5.2	7.0	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	16/01/2014 - 23:15:00	0.0	0.2	2.4	7.2	9.2	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	16/01/2014 - 23:15:00	0.0	0.2	2.2	5.8	8.6	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 23:15:00	0.0	0.2	1.6	5.8	7.2	98.2	112.0	113.8	0.0	Médio - 24h	
22	Santa Cruz	16/01/2014 - 23:15:00	0.0	0.0	0.6	4.8	9.4	52.2	56.4	76.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 23:15:00	0.0	0.4	1.8	5.8	7.2	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	16/01/2014 - 23:15:00	0.0	0.0	1.2	4.4	6.4	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	16/01/2014 - 23:15:00	0.0	0.0	2.2	6.0	8.2	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	16/01/2014 - 23:15:00	0.0	0.0	1.4	5.2	8.6	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	16/01/2014 - 23:15:00	0.0	0.0	0.6	4.0	7.8	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 23:15:00	0.0	0.2	2.0	6.8	8.6	80.0	84.0	86.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 23:15:00	0.0	0.0	1.6	6.0	10.0	39.6	40.8	43.4	0.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 23:15:00	0.0	0.2	2.4	6.8	8.6	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 23:15:00	0.0	0.4	2.2	6.0	8.0	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	16/01/2014 - 23:15:00	0.0	0.4	1.8	5.6	6.8	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	16/01/2014 - 23:15:00	0.0	0.2	1.8	5.6	6.8	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 23:30:00	0.0	0.0	1.0	4.4	6.0	80.8	80.8	80.8	0.0	Baixo	
2	Úrca	16/01/2014 - 23:30:00	0.0	0.0	1.4	4.8	6.6	34.6	34.6	34.6	0.0	Baixo	
3	Rocinha	16/01/2014 - 23:30:00	0.0	0.2	1.4	5.0	7.0	88.4	89.2	89.2	0.0	Médio - 24h	
4	Tijuca	16/01/2014 - 23:30:00	0.0	0.2	1.4	5.4	7.6	19.4	27.8	27.8	0.0	Baixo	
5	Santa Teresa	16/01/2014 - 23:30:00	0.2	0.2	1.2	5.4	8.0	24.4	24.8	25.0	0.8	Baixo	
6	Copacabana	16/01/2014 - 23:30:00	0.0	0.2	1.8	5.8	7.2	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	16/01/2014 - 23:30:00	0.0	0.2	1.2	5.6	7.8	83.8	114.0	114.0	0.0	Baixo	
8	Ilha do Governador	16/01/2014 - 23:30:00	0.0	0.2	0.8	3.6	6.6	25.4	33.6	35.2	0.0	Baixo	
9	Penha	16/01/2014 - 23:30:00	0.0	0.0	1.0	4.0	7.2	30.6	47.0	48.4	0.0	Baixo	
10	Madureira	16/01/2014 - 23:30:00	0.0	0.0	0.6	3.8	6.6	82.4	91.8	91.8	0.0	Baixo	
11	Itrajá	16/01/2014 - 23:30:00	0.0	0.0	0.8	3.4	6.2	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	16/01/2014 - 23:30:00	0.0	0.0	1.0	4.6	6.8	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	16/01/2014 - 23:30:00	0.0	0.0	1.0	4.4	6.6	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 23:30:00	0.0	0.2	1.2	5.0	8.0	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	16/01/2014 - 23:30:00	0.0	0.2	1.0	4.0	6.2	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	16/01/2014 - 23:30:00	0.0	0.2	1.4	5.4	7.0	53.8	54.0	54.0	0.0	Baixo	
17	Barra/Barrinha	16/01/2014 - 23:30:00	0.0	0.2	1.4	5.4	7.4	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 23:30:00	0.0	0.2	1.0	4.2	6.4	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	16/01/2014 - 23:30:00	0.0	0.0	1.8	6.0	8.8	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	16/01/2014 - 23:30:00	0.0	0.0	1.0	5.2	7.8	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 23:30:00	0.0	0.0	1.2	4.6	7.0	98.2	112.0	113.8	0.0	Médio - 24h	
22	Santa Cruz	16/01/2014 - 23:30:00	0.0	0.0	0.2	3.8	8.6	52.2	56.4	76.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 23:30:00	0.0	0.2	1.2	5.0	7.0	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	16/01/2014 - 23:30:00	0.0	0.0	0.6	3.8	6.0	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	16/01/2014 - 23:30:00	0.0	0.0	1.2	5.4	7.8	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	16/01/2014 - 23:30:00	0.0	0.0	0.8	4.0	7.8	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	16/01/2014 - 23:30:00	0.0	0.0	0.4	2.8	7.0	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 23:30:00	0.0	0.0	1.4	5.8	8.2	80.0	84.0	86.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 23:30:00	0.0	0.0	0.8	4.8	9.4	39.6	40.8	43.4	0.0	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 23:30:00	0.0	0.0	1.6	5.6	8.2	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 23:30:00	0.0	0.2	1.4	5.0	7.4	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	16/01/2014 - 23:30:00	0.0	0.2	1.0	4.6	6.8	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	16/01/2014 - 23:30:00	0.0	0.0	1.0	4.8	6.8	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.4	5.8	80.8	80.8	80.8	0.0	Baixo	
2	Úrca	16/01/2014 - 23:45:00	0.2	0.2	1.0	4.2	6.6	34.8	34.8	34.8	0.8	Baixo	
3	Rocinha	16/01/2014 - 23:45:00	0.0	0.2	0.8	3.8	6.4	88.4	89.2	89.2	0.0	Médo - 24h	
4	Tijuca	16/01/2014 - 23:45:00	0.2	0.2	1.0	4.4	7.6	19.6	28.0	28.0	0.0	Baixo	
5	Santa Teresa	16/01/2014 - 23:45:00	0.0	0.2	0.6	4.0	7.6	24.4	24.8	25.0	0.0	Baixo	
6	Copacabana	16/01/2014 - 23:45:00	0.0	0.0	1.2	4.8	7.0	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	16/01/2014 - 23:45:00	0.0	0.2	0.8	4.4	7.8	83.8	114.0	114.0	0.0	Baixo	
8	Ilha do Governador	16/01/2014 - 23:45:00	0.0	0.2	0.4	2.8	6.0	25.4	33.6	35.2	0.0	Baixo	
9	Penha	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.4	6.4	30.6	47.0	48.4	0.0	Baixo	
10	Madureira	16/01/2014 - 23:45:00	0.0	0.0	0.4	2.8	6.4	82.4	91.8	91.8	0.0	Baixo	
11	Irajá	16/01/2014 - 23:45:00	0.0	0.0	0.4	2.8	5.8	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	16/01/2014 - 23:45:00	0.0	0.0	0.4	3.6	6.4	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.4	6.4	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	16/01/2014 - 23:45:00	0.0	0.0	0.8	4.0	7.8	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	16/01/2014 - 23:45:00	0.0	0.0	0.4	3.2	5.8	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	16/01/2014 - 23:45:00	0.0	0.2	0.8	4.4	7.0	53.8	54.0	54.0	0.0	Baixo	
17	Barra/Barrinha	16/01/2014 - 23:45:00	0.0	0.2	1.0	4.2	7.2	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.2	6.2	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	16/01/2014 - 23:45:00	0.0	0.0	1.0	4.8	8.6	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	16/01/2014 - 23:45:00	0.0	0.0	0.6	4.2	7.2	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.6	7.0	98.2	112.0	113.8	0.0	Médo - 24h	
22	Santa Cruz	16/01/2014 - 23:45:00	0.0	0.0	0.0	2.6	6.8	52.2	56.4	76.6	0.0	Baixo	
23	Grande Méier	16/01/2014 - 23:45:00	0.0	0.2	0.8	4.0	6.8	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	16/01/2014 - 23:45:00	0.0	0.0	0.4	3.0	5.8	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	16/01/2014 - 23:45:00	0.0	0.0	0.4	4.4	7.2	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	16/01/2014 - 23:45:00	0.0	0.0	0.4	3.2	7.2	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	16/01/2014 - 23:45:00	0.0	0.0	0.2	2.2	5.8	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	16/01/2014 - 23:45:00	0.0	0.0	0.8	4.4	8.0	80.0	84.0	86.6	0.0	Baixo	
29	Av. Brasil/Mendanha	16/01/2014 - 23:45:00	0.2	0.2	0.4	3.8	8.4	39.8	41.0	43.6	0.8	Baixo	
30	Recreio dos Bandeirantes	16/01/2014 - 23:45:00	0.0	0.0	0.8	4.8	7.8	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	16/01/2014 - 23:45:00	0.0	0.2	0.8	4.0	7.0	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.6	6.4	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	16/01/2014 - 23:45:00	0.0	0.0	0.6	3.6	6.6	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.6	5.6	80.8	80.8	80.8	0.0	Baixo	
2	Úrca	17/01/2014 - 00:00:00	0.0	0.2	0.6	3.2	6.4	34.8	34.8	34.8	0.0	Baixo	
3	Rocinha	17/01/2014 - 00:00:00	0.0	0.2	0.6	2.8	6.2	88.4	89.2	89.2	0.0	Médo - 24h	
4	Tijuca	17/01/2014 - 00:00:00	0.0	0.2	0.6	3.4	7.4	19.6	28.0	28.0	0.0	Baixo	
5	Santa Teresa	17/01/2014 - 00:00:00	0.0	0.2	0.4	3.0	7.4	24.4	24.8	25.0	0.0	Baixo	
6	Copacabana	17/01/2014 - 00:00:00	0.0	0.0	0.6	3.6	6.8	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	17/01/2014 - 00:00:00	0.0	0.2	0.6	3.0	7.6	83.8	114.0	114.0	0.0	Baixo	
8	Ilha do Governador	17/01/2014 - 00:00:00	0.0	0.0	0.2	2.0	5.2	25.4	33.6	35.2	0.0	Baixo	
9	Penha	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.6	5.8	30.6	47.0	48.4	0.0	Baixo	
10	Madureira	17/01/2014 - 00:00:00	0.0	0.0	0.2	2.0	5.8	82.4	91.8	91.8	0.0	Baixo	
11	Irajá	17/01/2014 - 00:00:00	0.0	0.0	0.2	2.2	5.0	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	17/01/2014 - 00:00:00	0.0	0.0	0.2	2.8	6.0	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.2	6.0	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	17/01/2014 - 00:00:00	0.0	0.0	0.4	3.0	7.4	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.4	5.4	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	17/01/2014 - 00:00:00	0.0	0.2	0.6	3.2	6.8	53.8	54.0	54.0	0.0	Baixo	
17	Barra/Barrinha	17/01/2014 - 00:00:00	0.0	0.0	0.6	3.0	7.0	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.2	6.0	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	17/01/2014 - 00:00:00	0.0	0.0	0.4	3.4	8.2	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	17/01/2014 - 00:00:00	0.0	0.0	0.4	3.4	6.6	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.2	6.6	98.2	112.0	113.8	0.0	Médo - 24h	
22	Santa Cruz	17/01/2014 - 00:00:00	0.0	0.0	0.0	1.4	6.0	52.2	56.4	76.6	0.0	Baixo	
23	Grande Méier	17/01/2014 - 00:00:00	0.0	0.0	0.6	3.0	6.4	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	17/01/2014 - 00:00:00	0.0	0.0	0.0	2.2	5.2	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	17/01/2014 - 00:00:00	0.0	0.0	0.2	3.2	6.6	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	17/01/2014 - 00:00:00	0.0	0.0	0.2	2.4	6.6	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	17/01/2014 - 00:00:00	0.0	0.0	0.2	1.2	4.8	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	17/01/2014 - 00:00:00	0.2	0.2	0.6	3.2	7.8	80.2	84.2	86.8	0.8	Baixo	
29	Av. Brasil/Mendanha	17/01/2014 - 00:00:00	0.0	0.2	0.2	2.8	7.2	39.8	41.0	43.6	0.0	Baixo	
30	Recreio dos Bandeirantes	17/01/2014 - 00:00:00	0.0	0.0	0.4	3.4	7.4	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	17/01/2014 - 00:00:00	0.0	0.0	0.4	3.0	6.6	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.6	6.2	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	17/01/2014 - 00:00:00	0.0	0.0	0.4	2.6	6.6	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,8	5,0	80,8	80,8	80,8	0,0	Baixo	
2	Urca	17/01/2014 - 00:15:00	0,0	0,2	0,4	2,4	6,0	34,8	34,8	34,8	0,0	Baixo	
3	Rocinha	17/01/2014 - 00:15:00	0,0	0,0	0,4	2,2	5,6	88,4	89,2	89,2	0,0	Mélio - 24h	
4	Tijuca	17/01/2014 - 00:15:00	0,0	0,2	0,6	2,6	6,6	19,6	28,0	28,0	0,0	Baixo	
5	Santa Teresa	17/01/2014 - 00:15:00	0,0	0,2	0,4	2,2	6,6	24,4	24,8	25,0	0,0	Baixo	
6	Copacabana	17/01/2014 - 00:15:00	0,0	0,0	0,4	2,6	6,6	42,0	42,0	42,0	0,0	Baixo	
7	Grajaú	17/01/2014 - 00:15:00	0,0	0,0	0,4	2,0	6,8	83,8	114,0	114,0	0,0	Baixo	
8	Ilha do Governador	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,4	4,2	25,4	33,6	35,2	0,0	Baixo	
9	Penha	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,6	4,8	30,6	47,0	48,4	0,0	Baixo	
10	Madureira	17/01/2014 - 00:15:00	0,0	0,0	0,0	1,4	4,6	82,4	91,8	91,8	0,0	Baixo	
11	Irará	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,6	4,2	74,6	91,6	91,6	0,0	Baixo	
12	Bangu	17/01/2014 - 00:15:00	0,0	0,0	0,0	2,0	5,4	19,0	19,0	33,4	0,0	Baixo	
13	Piedade	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,4	5,2	84,6	104,8	105,2	0,0	Baixo	
14	Jacarepaguá/Tanque	17/01/2014 - 00:15:00	0,0	0,0	0,2	2,0	6,4	54,2	67,8	67,8	0,0	Baixo	
15	Saúde	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,6	5,0	33,2	37,2	37,4	0,0	Baixo	
16	Jardim Botânico	17/01/2014 - 00:15:00	0,0	0,0	0,4	2,4	6,2	53,8	54,0	54,0	0,0	Baixo	
17	Barra/Barrinha	17/01/2014 - 00:15:00	0,0	0,0	0,4	2,0	6,4	73,6	74,0	74,0	0,0	Baixo	
18	Jacarepaguá/Cidade de Deus	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,4	5,2	55,2	59,0	59,0	0,0	Baixo	
19	Barra/Riocentro	17/01/2014 - 00:15:00	0,0	0,0	0,2	2,4	7,2	77,2	78,0	78,0	0,0	Baixo	
20	Guaratiba	17/01/2014 - 00:15:00	0,0	0,0	0,2	2,2	5,8	37,2	43,6	85,4	0,0	Baixo	
21	Est. Grajaú/Jacarepaguá	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,6	5,8	98,2	112,0	113,8	0,0	Mélio - 24h	
22	Santa Cruz	17/01/2014 - 00:15:00	0,0	0,0	0,0	0,6	4,8	52,2	56,4	76,6	0,0	Baixo	
23	Grande Méier	17/01/2014 - 00:15:00	0,0	0,0	0,4	1,8	5,8	57,4	80,4	80,4	0,0	Baixo	
24	Anchieta	17/01/2014 - 00:15:00	0,0	0,0	0,0	1,2	4,4	28,6	35,0	35,0	0,0	Baixo	
25	Grota Funda	17/01/2014 - 00:15:00	0,0	0,0	0,0	2,2	6,0	46,6	48,2	56,0	0,0	Baixo	
26	Campo Grande	17/01/2014 - 00:15:00	0,0	0,0	0,0	1,4	5,2	67,6	67,6	72,0	0,0	Baixo	
27	Sepetiba	17/01/2014 - 00:15:00	0,0	0,0	0,0	0,6	4,0	11,8	13,8	49,4	0,0	Baixo	
28	Alto da Boa Vista	17/01/2014 - 00:15:00	0,0	0,2	0,4	2,2	7,0	80,2	84,2	86,8	0,0	Baixo	
29	Av. Brasil/Mendanha	17/01/2014 - 00:15:00	0,0	0,2	0,2	1,8	6,2	39,8	41,0	43,6	0,0	Baixo	
30	Recreio dos Bandeirantes	17/01/2014 - 00:15:00	0,0	0,0	0,2	2,4	6,8	45,6	47,4	47,4	0,0	Baixo	
31	Laranjeiras	17/01/2014 - 00:15:00	0,0	0,0	0,4	2,2	6,0	32,4	32,6	32,8	0,0	Baixo	
32	São Cristóvão	17/01/2014 - 00:15:00	0,0	0,0	0,4	1,8	5,6	20,2	38,2	38,2	0,0	Baixo	
33	Tijuca/Muda	17/01/2014 - 00:15:00	0,0	0,0	0,2	1,8	5,6	35,2	50,4	50,4	0,0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,0	4,4	80,8	80,8	80,8	0,0	Baixo	
2	Urca	17/01/2014 - 00:30:00	0,0	0,2	0,2	1,6	5,0	34,8	34,8	34,8	0,0	Baixo	
3	Rocinha	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,4	5,0	88,4	89,2	89,2	0,0	Mélio - 24h	
4	Tijuca	17/01/2014 - 00:30:00	0,0	0,2	0,4	1,6	5,6	19,6	28,0	28,0	0,0	Baixo	
5	Santa Teresa	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,2	5,4	24,4	24,8	25,0	0,0	Baixo	
6	Copacabana	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,8	5,8	42,0	42,0	42,0	0,0	Baixo	
7	Grajaú	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,2	5,6	83,8	114,0	114,0	0,0	Baixo	
8	Ilha do Governador	17/01/2014 - 00:30:00	0,0	0,0	0,2	0,8	3,6	25,4	33,6	35,2	0,0	Baixo	
9	Penha	17/01/2014 - 00:30:00	0,2	0,2	0,2	1,2	4,2	30,8	47,2	48,6	0,8	Baixo	
10	Madureira	17/01/2014 - 00:30:00	0,0	0,0	0,0	0,6	3,8	82,4	91,8	91,8	0,0	Baixo	
11	Irará	17/01/2014 - 00:30:00	0,0	0,0	0,0	0,8	3,4	74,6	91,6	91,6	0,0	Baixo	
12	Bangu	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,0	4,6	19,0	19,0	33,4	0,0	Baixo	
13	Piedade	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,0	4,4	84,6	104,8	105,2	0,0	Baixo	
14	Jacarepaguá/Tanque	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,2	5,0	54,2	67,8	67,8	0,0	Baixo	
15	Saúde	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,0	4,0	33,2	37,2	37,4	0,0	Baixo	
16	Jardim Botânico	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,4	5,4	53,8	54,0	54,0	0,0	Baixo	
17	Barra/Barrinha	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,4	5,4	73,6	74,0	74,0	0,0	Baixo	
18	Jacarepaguá/Cidade de Deus	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,0	4,2	55,2	59,0	59,0	0,0	Baixo	
19	Barra/Riocentro	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,8	6,0	77,2	78,0	78,0	0,0	Baixo	
20	Guaratiba	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,0	5,2	37,2	43,6	85,4	0,0	Baixo	
21	Est. Grajaú/Jacarepaguá	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,2	4,6	98,2	112,0	113,8	0,0	Mélio - 24h	
22	Santa Cruz	17/01/2014 - 00:30:00	0,2	0,2	0,2	0,4	4,0	52,4	56,6	76,8	0,8	Baixo	
23	Grande Méier	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,2	5,0	57,4	80,4	80,4	0,0	Baixo	
24	Anchieta	17/01/2014 - 00:30:00	0,0	0,0	0,0	0,6	3,8	28,6	35,0	35,0	0,0	Baixo	
25	Grota Funda	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,2	5,4	46,6	48,2	56,0	0,0	Baixo	
26	Campo Grande	17/01/2014 - 00:30:00	0,0	0,0	0,0	0,8	4,0	67,6	67,6	72,0	0,0	Baixo	
27	Sepetiba	17/01/2014 - 00:30:00	0,0	0,0	0,0	0,4	2,8	11,8	13,8	49,4	0,0	Baixo	
28	Alto da Boa Vista	17/01/2014 - 00:30:00	0,0	0,2	0,2	1,6	6,0	80,2	84,2	86,8	0,0	Baixo	
29	Av. Brasil/Mendanha	17/01/2014 - 00:30:00	0,0	0,2	0,2	1,0	5,0	39,8	41,0	43,6	0,0	Baixo	
30	Recreio dos Bandeirantes	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,6	5,6	45,6	47,4	47,4	0,0	Baixo	
31	Laranjeiras	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,4	5,0	32,4	32,6	32,8	0,0	Baixo	
32	São Cristóvão	17/01/2014 - 00:30:00	0,0	0,0	0,2	1,0	4,6	20,2	38,2	38,2	0,0	Baixo	
33	Tijuca/Muda	17/01/2014 - 00:30:00	0,0	0,0	0,0	1,0	4,8	35,2	50,4	50,4	0,0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	3.4	80.8	80.8	80.8	0.0	Baixo	
2	Urca	17/01/2014 - 00:45:00	0.0	0.0	0.2	1.0	4.2	34.8	34.8	34.8	0.0	Baixo	
3	Rocinha	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.8	3.8	88.4	89.2	89.2	0.0	Médio - 24h	
4	Tijuca	17/01/2014 - 00:45:00	0.0	0.0	0.2	1.0	4.4	19.6	28.0	28.0	0.0	Baixo	
5	Santa Teresa	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.6	4.0	24.4	24.8	25.0	0.0	Baixo	
6	Copacabana	17/01/2014 - 00:45:00	0.0	0.0	0.0	1.2	4.8	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.8	4.4	83.8	114.0	114.0	0.0	Baixo	
8	Ilha do Governador	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.4	2.8	25.4	33.6	35.2	0.0	Baixo	
9	Penha	17/01/2014 - 00:45:00	0.0	0.2	0.2	0.8	3.6	30.8	47.2	48.6	0.0	Baixo	
10	Madureira	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	2.8	82.4	91.8	91.8	0.0	Baixo	
11	Irará	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	2.8	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	3.6	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	3.4	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.8	4.0	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	3.2	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.8	4.4	53.8	54.0	54.0	0.0	Baixo	
17	Barra/Barrinha	17/01/2014 - 00:45:00	0.0	0.0	0.2	1.0	4.2	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	3.2	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	17/01/2014 - 00:45:00	0.0	0.0	0.0	1.0	4.8	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	4.2	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	3.6	98.2	112.0	113.8	0.0	Médio - 24h	
22	Santa Cruz	17/01/2014 - 00:45:00	0.0	0.2	0.2	0.2	2.8	52.4	56.6	76.8	0.0	Baixo	
23	Grande Méier	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.8	4.0	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	3.0	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	4.4	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.4	3.2	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.2	2.2	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	17/01/2014 - 00:45:00	0.0	0.2	0.2	1.0	4.6	80.2	84.2	86.8	0.0	Baixo	
29	Av. Brasil/Mendanha	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.4	3.8	39.8	41.0	43.6	0.0	Baixo	
30	Recreio dos Bandeirantes	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.8	4.8	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	17/01/2014 - 00:45:00	0.0	0.0	0.2	0.8	4.0	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	3.6	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	17/01/2014 - 00:45:00	0.0	0.0	0.0	0.6	3.6	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escorregame...	
1	Vidigal	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.6	80.8	80.8	80.8	0.0	Baixo	
2	Urca	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.6	3.2	34.8	34.8	34.8	0.0	Baixo	
3	Rocinha	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.6	2.8	88.4	89.2	89.2	0.0	Médio - 24h	
4	Tijuca	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.6	3.4	19.6	28.0	28.0	0.0	Baixo	
5	Santa Teresa	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.4	3.0	24.4	24.8	25.0	0.0	Baixo	
6	Copacabana	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.6	3.6	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.6	3.0	83.8	114.0	114.0	0.0	Baixo	
8	Ilha do Governador	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	2.0	25.4	33.6	35.2	0.0	Baixo	
9	Penha	17/01/2014 - 01:00:00	0.0	0.2	0.2	0.6	2.8	30.8	47.2	48.6	0.0	Baixo	
10	Madureira	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	2.0	82.4	91.8	91.8	0.0	Baixo	
11	Irará	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	2.2	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	2.8	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.2	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	3.0	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.4	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.6	3.2	53.8	54.0	54.0	0.0	Baixo	
17	Barra/Barrinha	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.6	3.0	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.2	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	3.4	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	3.4	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.2	98.2	112.0	113.8	0.0	Médio - 24h	
22	Santa Cruz	17/01/2014 - 01:00:00	0.0	0.2	0.2	0.2	1.6	52.4	56.6	76.8	0.0	Baixo	
23	Grande Méier	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.6	3.0	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.0	2.2	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	3.2	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	2.4	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.2	1.2	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.6	3.2	80.2	84.2	86.8	0.0	Baixo	
29	Av. Brasil/Mendanha	17/01/2014 - 01:00:00	0.0	0.0	0.2	0.2	2.8	39.8	41.0	43.6	0.0	Baixo	
30	Recreio dos Bandeirantes	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	3.4	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	3.0	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.6	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	17/01/2014 - 01:00:00	0.0	0.0	0.0	0.4	2.6	35.2	50.4	50.4	0.0	Baixo	

Identificação			Chuvvas										Alarmes
N.º	Estações	Hora Leitura	15 min	01h	02h	03h	04h	24h	96h	No Mês	Taxa em 01H	Escoregame...	
1	Vidigal	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.0	80.8	80.8	80.8	0.0	Baixo	
2	Urca	17/01/2014 - 01:30:00	0.0	0.0	0.2	0.2	1.6	34.8	34.8	34.8	0.0	Baixo	
3	Rocinha	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.4	88.4	89.2	89.2	0.0	Médo - 24h	
4	Tijuca	17/01/2014 - 01:30:00	0.0	0.0	0.2	0.4	1.6	19.6	28.0	28.0	0.0	Baixo	
5	Santa Teresa	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.2	24.4	24.8	25.0	0.0	Baixo	
6	Copacabana	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.8	42.0	42.0	42.0	0.0	Baixo	
7	Grajaú	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.2	83.8	114.0	114.0	0.0	Baixo	
8	Ilha do Governador	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	0.8	25.4	33.6	35.2	0.0	Baixo	
9	Penha	17/01/2014 - 01:30:00	0.0	0.0	0.2	0.2	1.2	30.8	47.2	48.6	0.0	Baixo	
10	Madureira	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	0.6	82.4	91.8	91.8	0.0	Baixo	
11	Irajá	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	0.8	74.6	91.6	91.6	0.0	Baixo	
12	Bangu	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.0	19.0	19.0	33.4	0.0	Baixo	
13	Piedade	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.0	84.6	104.8	105.2	0.0	Baixo	
14	Jacarepaguá/Tanque	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.2	54.2	67.8	67.8	0.0	Baixo	
15	Saúde	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.0	33.2	37.2	37.4	0.0	Baixo	
16	Jardim Botânico	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.4	53.8	54.0	54.0	0.0	Baixo	
17	Barra/Barrinha	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.4	73.6	74.0	74.0	0.0	Baixo	
18	Jacarepaguá/Cidade de Deus	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.0	55.2	59.0	59.0	0.0	Baixo	
19	Barra/Riocentro	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.8	77.2	78.0	78.0	0.0	Baixo	
20	Guaratiba	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.0	37.2	43.6	85.4	0.0	Baixo	
21	Est. Grajaú/Jacarepaguá	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.2	98.2	112.0	113.8	0.0	Médo - 24h	
22	Santa Cruz	17/01/2014 - 01:30:00	0.0	0.0	0.2	0.2	0.4	52.4	56.6	76.8	0.0	Baixo	
23	Grande Méier	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.2	57.4	80.4	80.4	0.0	Baixo	
24	Anchieta	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	0.6	28.6	35.0	35.0	0.0	Baixo	
25	Grota Funda	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.2	46.6	48.2	56.0	0.0	Baixo	
26	Campo Grande	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	0.8	67.6	67.6	72.0	0.0	Baixo	
27	Sepetiba	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	0.4	11.8	13.8	49.4	0.0	Baixo	
28	Alto da Boa Vista	17/01/2014 - 01:30:00	0.0	0.0	0.2	0.2	1.6	80.2	84.2	86.8	0.0	Baixo	
29	Av. Brasil/Mendanha	17/01/2014 - 01:30:00	0.0	0.0	0.2	0.2	1.0	39.8	41.0	43.6	0.0	Baixo	
30	Recreio dos Bandeirantes	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.6	45.6	47.4	47.4	0.0	Baixo	
31	Laranjeiras	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.4	32.4	32.6	32.8	0.0	Baixo	
32	São Cristóvão	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.2	1.0	20.2	38.2	38.2	0.0	Baixo	
33	Tijuca/Muda	17/01/2014 - 01:30:00	0.0	0.0	0.0	0.0	1.0	35.2	50.4	50.4	0.0	Baixo	