Poster: Building Comprehensive Telecommunications Datasets During a Major Climatic Event

Leandro Márcio Bertholdo
UFRGS
Porto Alegre, Brazil
leandro.bertholdo@ufrgs.br

Renan Barreto Paredes
FURG
Rio Grande, Brazil
renan.barreto@furg.br

Pedro de Botelho Marcos
FURG
Rio Grande, Brazil
pbmarcos@furg.br

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1 Introduction

In May 2024, an entire month of severe rainfall in Rio Grande do Sul, Brazil, caused extensive infrastructure damage across over 400 cities, disrupting roads, power plants, and communication infrastructures [4]. As a result, 2.3 million people were directly affected, reducing economic activity by 94%. In disaster scenarios, communication systems are vital for coordinating rescue efforts, providing crowd-sourced information on interrupted roads and bridges, and keeping the economy running to prevent looting.

Several works observe or forecast [3, 6] the impact on communications during major events affecting infrastructure through measurements. However, the lack of transparent, trustworthy, and real datasets about these events sometimes makes it difficult to explain findings or validate methods capable of forecasting the impact on telecommunications in these scenarios [1]. Our contribution with this poster is to inform the community about the datasets we are building from that major climate event, report our initial findings, and discuss potential additional data sources.

2 Methodology

We are cataloging data for future analyses and simulations. This includes event timelines, hydrologic causes, maps, data center conditions, and Internet measurements from end-users, public schools, and health units via the Simet system [5]. Additionally, we have collected Internet routing and traffic data from the Porto Alegre IXP (IX.br) and a mobile operator, documented fiber cuts and repairs in two metropolitan networks, and gathered data on long-distance circuit outages. Furthermore, we have supplemented this data with information from operator management systems, private contributions, and official reports. We are making intermediate datasets available to the community, as described in [2], as we obtain the necessary authorizations from all relevant parties. In the following sections, we present the initial findings derived from these datasets.

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3 Data Centers in the State Capital

In recent years, several data centers were established in neighborhoods close to the city center and the airport, situated along the banks of the Guaíba and Jacuí Rivers, and were heavily affected by the flooding event. Starting on May 3rd, several data centers were shut down, affecting the Court of Justice, the state government, the incumbent, and a Tier-3 that hosts major content companies and is a part of the Porto Alegre IXP. As a result, 21 out of 35 known data centers in the capital went out of service, disrupting government services such as online identity verification, tax processing, and social security payments.

While some data centers were shut down as a precaution, most suffered significant damage to electrical systems and backup generators. The biggest challenge registered was to fuel generators. Between success stories, a Wholesale provider continued to operate successfully by transporting fuel via boats for their generators [7]. Others, like a Bank and an incumbent, switched their operations to a second data center on higher ground. Data centers on high floors in flooded areas (e.g., the 25th floor) were closed after a week by requiring manual fuel transport. Fig. 1 use this dataset.

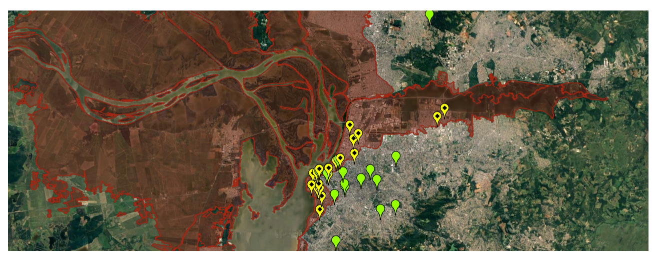

Figure 1: Data center statuses: yellow pins indicate shut down, green active, and red flooded terrain.

4 Optical Fiber Paths

The metropolitan network datasets, covering 2022 to 2024, reveals a direct correlation between fiber ruptures and climate-related events such as Cyclone Yakecan in 2022, a series of thunderstorms in 2023, and flooding in May 2024. In Brazil, aerial fibers are commonly installed at a height of 4 meters on utility poles. Many cables were cut during rescue operations to facilitate the passage of high trucks and boats carrying rescued people, thereby preventing accidents. One provider registered 1,500% increase on fiber cuts in May 2024.

The bad weather also increased the mean time to repair cables by two days, as electrical storms made climbing poles unsafe. Aerial networks allowed for the creation of new emergency paths and the movement of customers' ICT infrastructure to other locations. Regarding underground cables, no damage was registered, but only companies that fused all fibers in each subterranean splice box could take advantage of that. Underground infrastructure was important for moving the government's crisis room to another location.

5 IXP Reachability

From the Porto Alegre IXP dataset, we can identify which ISPs and data centers lost connectivity to their upstream providers and to the IXP. The IXP traffic volume dropped by 50% (450 Gbps) but started to recover a week later as sixteen ISPs rebuilt their connectivity using the IXP infrastructure to reestablish transit agreements. The IXP routing data from April 16 to May 24 revealed significant drops in reachable ASes during key moments of the storms. For instance, during the first storm wave on April 27, the number of reachable ASes dropped by 10.1%, and on May 5, it decreased by 15.1%. Reachability had not fully recovered by May 24, with an additional drop observed on May 23 during another rainfall.

The data also allow us to identify that the average path size of routes increased, reflecting the challenges faced by the infrastructure and showing several alternate paths. In Fig. 2, we illustrate the average path size behavior seen on the IXP during the flooding period. We can notice that as the flooding propagated through the state, the path to each remaining network increased its average length (IPv4). The sharp decline on May 3 and May 4 corresponded with failures in Route Server 2, indicating the critical role of redundancy in maintaining connectivity. Despite these challenges, the IXP managed to keep connectivity between and to ASes in the region, with the redundancy of route servers proving essential in minimizing the impact during critical moments.

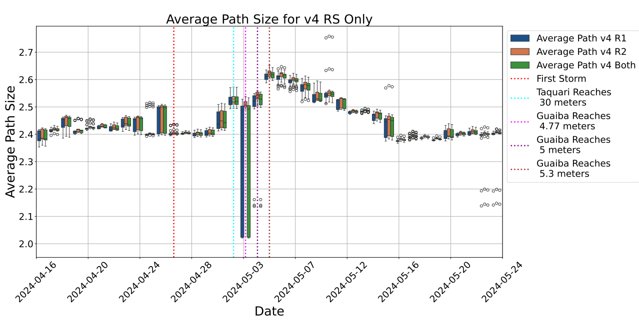

Figure 2: Average IPv4 path size changes.

6 User-initiated Measurements

The SIMET datasets are obtained from a traffic measurement system run by the Brazilian Network Information Center (NIC.br) for end-user network quality tests, similar to platforms like SpeedTest. There are two types of measurements: on-demand tests conducted by end-users through mobile applications, and periodic tests carried out via installed software in 5,171 public schools.

The data show that an increase in end-user measurements (+45%) was accompanied by a decrease in school measurements (−38%) during the event (see Fig. 3). Between April 8 and 12, 4,149 schools measured Internet quality at least once, compared to 3,182 between May 6 and 10. There was a recovery between June 3 and 7, with 4,129 schools measuring Internet quality. We attribute this negative correlation to school closures and users performing speed tests when Internet quality is perceived to be worse.

From on-demand end-users tests is possible to observe a vacuum of measurements in the flooded area during the weeks following the flood. Although this decrease is not expected according to the idea that users measure the Internet quality when they are not satisfied, it can be explained by both a complete lack of Internet access, or due to rearranging priorities (*i.e.*, people were using less the Internet because they were worried about other things). Further investigations should be able to determine which of these factors.

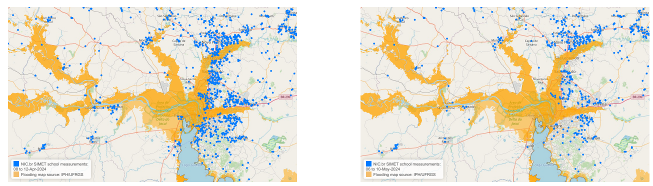

Figure 3: Public schools in the Porto Alegre metropolitan area with at least one measurement before (left) and during (right) the severe weather events in May.

7 Acknowledgments and Final Remark

Our preliminary analysis of these datasets indicates that they can be a useful source for evaluating technical and operational standards, providing insights into running fiber networks and data centers, better understanding user behavior, and assessing the effects on mobile networks and internet traffic exchange in long-term critical situations

We thank the Brazilian Network Information Center (NIC.br), the Brazilian Research and Education Network (RNP), the regional ISPs association (InternetSul), and several individuals and companies who preferred to remain anonymous. We are still looking for data from other sources, such as the geolocation of 1,000 LEO satellite antennas donated by Starlink, and addicional datasets such as those from mobile operators in the region.

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