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Delivering remote flood analytics as a scalable service

Operationalizing satellite-based and near real-time flood monitoring for local emergency response in the Republic of the Congo

Introduction

A community's ability to absorb a shock and prevent a flood from becoming a disaster is key to its long term resilience. However, governments, communities and other actors can only reliably reduce the number of deaths and protect their economies if they know where vulnerable people and assets are when a disaster occurs or looks likely to occur. For flood preparedness, the identification of people and assets most exposed to flooding enables government and aid agencies to prepare aid and plan a response, as well as rezone assets and design protective infrastructure.

Each year humanitarian relief meets only seven percent of economic losses from disasters in the developing world. With floods doubling worldwide (because of climate change and population migration), increasing aid after a disaster is only part of the solution. It is critically important to significantly decrease the estimated USD 29.9 billion losses that occur as a result of flooding every year by enabling vulnerable countries to reduce their risk and address impacts more effectively. This starts with information and the ability to use it. If governments and other responders do not have locally relevant information about a flood, they cannot prepare for it or respond effectively when it happens.

Traditional flood mapping is manual, slow and expensive – it requires locally gathered and calibrated models for high accuracy, sometimes taking years to map a stretch of river, and can cost millions per project. However, C2S's flood analytics and monitoring from satellites, produces high resolution and near real-time monitoring and is fast and accessible even to users with limited risk modeling training and unreliable Internet services.

C2S's platform harnesses dozens of global satellites and community intelligence to detect disasters as they happen, predict elevated flood risk situations, and provide flood vulnerability maps at a fraction of the cost and time of traditional methods. Customized versions of the platform that integrate the science of local flood dynamics are designed to support flood response and long-term preparation for a country's government. First, near real-time flood monitoring alerts the government to flooding anywhere in the country and rapidly pinpoints people affected during a crisis and helps in delivering the disaster relief needed. With distilled short offline messages and interactive decision support, managers can quickly share damage

reports with everyone from international agencies to first responders. Second, calibrated flood triggers, based on local flood and weather dynamics, warn users of potential flooding before it happens. Third, flood frequency and probability maps based on tens of thousands of satellite images over 35 years reveal areas of risk and can be updated with a click of a button. These analytics enable authorities to keep people and assets out of flood prone areas, design dykes and dams, identify wetlands, and more.

C2S has provided flood analytics to over nine countries, with a plan to be in 50 with over 200 projects by the end of 2022 through partnerships with existing insurance partners, governments and aid agencies.

The following report is an example of a recent pilot project in the Republic of the Congo between the government, the UN World Food Programme (WFP) and Cloud to Street. UN WFP worked with C2S through its Innovation Accelerator programme which supports and scales high potential solutions to hunger worldwide. The WFP Innovation Accelerator programme identified and utilized C2S's service for their humanitarian response activities by leveraging C2S's transformative technology.

Context

In November 2017, the city of Impfondo in the Republic of the Congo experienced a serious flood event, leaving 5 000 people in need of food assistance. However, the WFP did not learn of the flood for an entire month after it occurred, and once they did receive information about it, information about the size of the flood and the need for food was unclear, thus delaying the response. Alerts about the flood initially came by word of mouth, and later from field staff deployed from the capital.

The goal of this pilot project was to demonstrate the value of flood information services based on satellite imagery for monitoring floods. C2S sought to assess whether or not satellite imagery could deliver useable and impactful data on flooding to WFP and to the government ministries of the Republic of Congo. For WFP, this would mean reducing response times by rapidly assessing if, where, and how much food relief was required. For the Congolese government, this would mean providing information on flooding located in remote parts of the country where there is little regular contact. The goal of both stakeholders was to improve on the benchmark set by the November 2017 Impfondo flood event.

C2S proposed testing the impact of its near real-time satellite flood monitoring service on three critical disaster emergency activities in the country: 1) food relief by WFP; 2) government response to floods; and 3) coordination between stakeholders during a crisis.

C2S designed and implemented a locally customized automated flood and rainfall monitoring online tool, provided as a service within an interactive dashboard for government and WFP users. Government users, based in Brazzaville, included the Ministry of Social Affairs and Humanitarian Action, the Meteorology Office, and the HydroMet Office, among others. The system scientifically optimized and combined global flood detection algorithms to the unique flood dynamics of the region to generate flood analysis and reports that can be verified from the ground and shared through WhatsApp alerts daily.

This service has three main features:

1. a user-centered dashboard and offline tools customized for the most important local flood needs based on what information can reduce flood vulnerability;
2. flood information leveraging the best available science, satellites, and community intelligence; and
3. day-to-day support and local capacity building to make sure users understand the data and can use the information to make decisions.

Cloud to Street's approach to flood detection and response is shown in Figure 19.

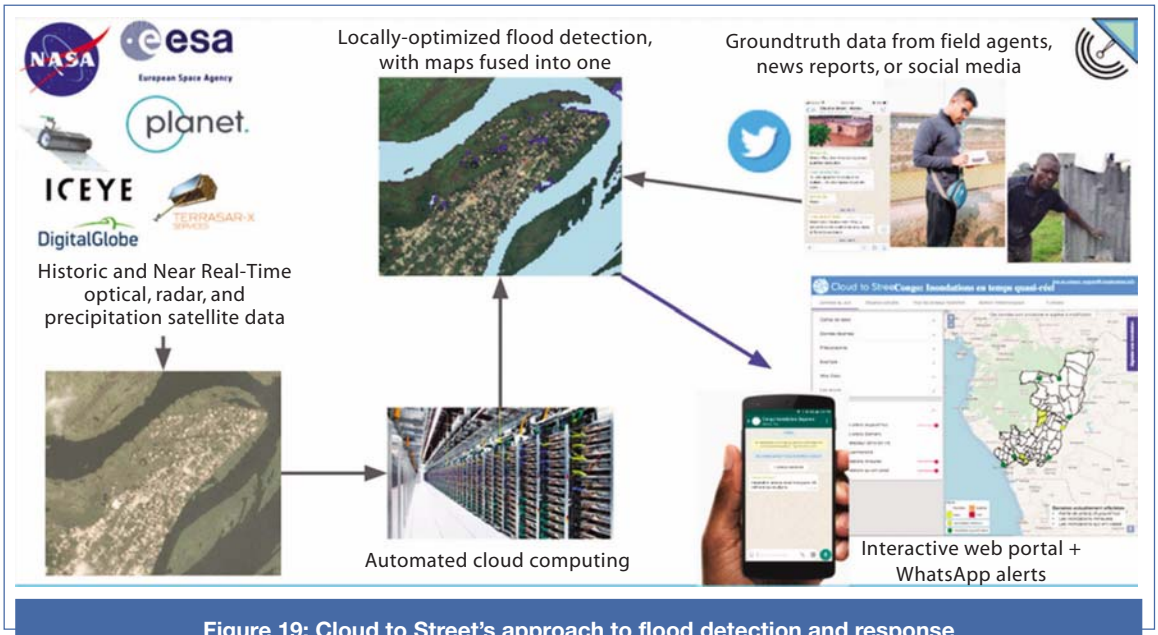

Figure 19: Cloud to Street's approach to flood detection and response

Starting with optical, radar, and precipitation satellite data, and leveraging automated cloud computing and groundtruth data from field agents, news reports, or social media, C2S perform locally-optimized flood detection. The results are then presented in an interactive dashboard combining flood analysis and reports (Figure 20).

"A" shows the "recent data" page, which contains a map of precipitation alerts by district, with locations of observed flooding events throughout the country. Collapsible groups of layers on the left allow for the display of different precipitation, flood, and contextual information. The "Report a flood" button in blue (not shown here) allows users to manually report a flood to C2S. "B" shows the "current situation" page, which summarizes the latest information on each flooding event using satellite imagery, flood model results, and rainfall levels. "C" shows the "meteorological bulletin" page, which provides monthly and ten-day summaries of rainfall throughout the country compared to historical averages. "D" shows the "daily rainfall from the HydroMet Office" page providing automatic daily precipitation data for two weeks before and after the current date, allowing power users to download tabular data for use in their own reports and analyses.

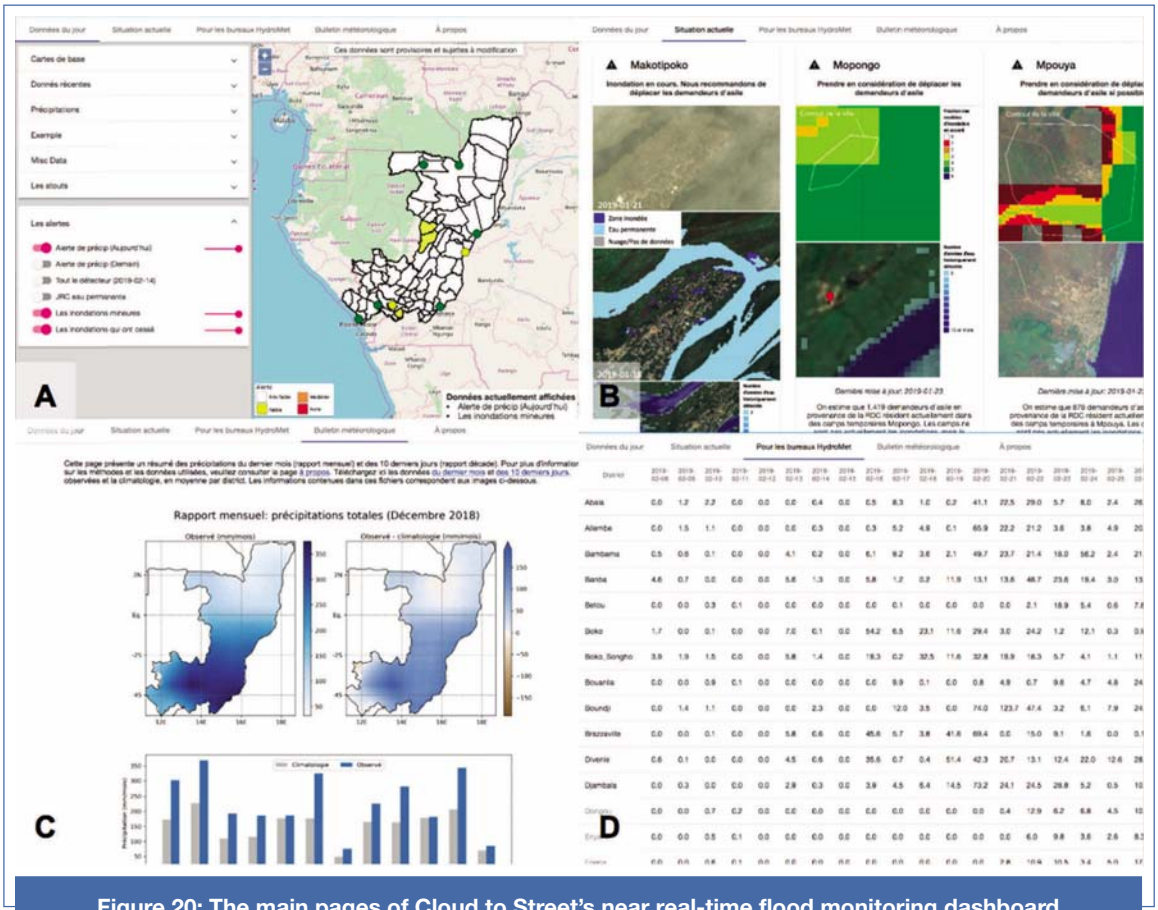

Figure 20: The main pages of Cloud to Street's near real-time flood monitoring dashboard

In operating this system, C2S created rapid flood maps designed to be useful for decision making, initially with public satellite imagery and then also using commercial satellite imagery when public satellite imagery was not sufficient for providing useful information on flood occurrence.

Overview of findings

Over the course of monitoring, the C2S system identified eight flood events and assessed the flood risk of four additional sites with asylum seekers. Five of the eight events were identified using public satellite tools and three were reported by local stakeholders in urban areas. These floods impacted 33 homes in Makotipoko, 26 homes in Mossaka, at least 11 homes in Nkayi, and also identified flooded roads and the risk of larger potential flooding in Ouesso and Sembe.

The flooding event in Mossaka was the strongest example of the value of timely flood information. Flooding was first detected by Sentinel-2 satellite imagery in the town of Mossaka on 9 November, and parts of the town continued to flood intermittently until 18 January. In addition to the Mossaka flooding event, C2S's system detected minor or potential flooding

in three other towns (Nkayi, Ouesso and Sembe). C2S communicated these situations to a WhatsApp group and recommended contacting local field agents for confirmation.

User design exercise for local stakeholders

Cloud to Street used human-centered design methods, customized for flood decision making in the developing world, in order to assess the true needs and capacities of its users. Starting with these user design methods – not prescribed technological solutions – helped ensure that we provided what the end users wanted and that they could unlock the value of what they got, and that the solutions would therefore inspire long-term use of the tool. Exercises centred around stakeholder mapping and timeline analyses for recovery efforts and extensive scenario discussions to ensure a usable design product.

Overall, the process proved essential for identifying key local stakeholder groups, clarifying the chain of command, identifying where information could change the flood process in places, and profiling the current capacity in general.

Outcomes

1. Flood monitoring for asylum seeker sites

On 28 December, Cloud to Street was made aware that about 17 000 asylum seekers from the neighbouring Democratic Republic of the Congo had crossed the border and sought refuge in several sites along the Congo River on the Republic of the Congo side. The UN Refugee Agency (UNHCR) was concerned about the flood risk of these sites, and sought information from external sources. C2S mobilized quickly, providing an initial briefing on the flood risk based on historical flood patterns by 29 December.

By 3 January, additional information from six flood models was provided for a more comprehensive assessment of flood risk. At that point, daily checks of the four main asylum seeker sites to the monitoring process were included in case flooding occurred; this also included providing daily information on “current situation” cards for local decision makers. On 16 January, these recommendations were presented to UNHCR formally, which was then conveyed by them to local government actors on the ground.

On 8 February, UNHCR reported that the government agreed to relocate refugees from the highest risk site (Makotipoko) to one of the sites with lower risk (Bouemba). Makotipoko was also the site with the largest number of refugees and this timely evacuation averted an impending disaster. For C2S, this represented the successful deployment of critical satellite information in a way that spurs quick interventions from the government and aid agencies.

2. Building coordination and capacity through WhatsApp

The system was designed to provide useable flood information for government users to incorporate into their decision-making process. The initial assumption had been that government users would check the pages of the dashboard regularly, or would check the dashboard when alerted. However, as the pilot project proceeded, it was found that more direct communication through WhatsApp allowed for greater uptake of flood alert information based on monitoring web visits to the dashboard from Brazzaville using Google Analytics. Therefore, a local WhatsApp group with representatives from different government ministries and other local stakeholders was created and subsequently daily summaries of the "current situation" page were sent to that group. This allowed for confirmation from users on the ground about events observed with C2S's system. The WhatsApp group served as a focal point of coordination among ministries who had previously lacked a common source of information about flooding.

3. Building technical capacity through training

Cloud to Street added to local capacity of the government ministries through training at the pilot project's onset in October, through monthly updates starting in December, and through shared coordination around flooding using the WhatsApp group. On 2 November, 18 officials from seven government ministries attended a training event on the C2S System. During subsequent monthly conference calls attended by stakeholders, they received new information from the system. In total, 28 local stakeholders were trained on how to use the service, with 18 from local Congolese government offices and ten from non-governmental agencies such as WFP.

Challenges to flood resilience in the Congo

1. Coordination between stakeholders

Lack of clear coordination between various stakeholder groups made it difficult to assign responsibility clearly to specific ministries during a serious flood event. It is noteworthy that during a fact-finding session (part of which involved groups of participants in creating maps) initiated by C2S prior to service implementation (Figure 21), each group drew a stakeholder map to communicate their understanding of which ministry was responsible during a flood emergency and there was no consensus on the chain of command or process.

"A" shows a prototypical stakeholder map drawn by a government ministry user communicating the chain of command for responding to floods. The blue circle shows the Ministry of Social Affairs at the centre of other actors, something disputed by that particular ministry.

Figure 21: Communication capacity for flood emergencies in Republic of the Congo

2. Data availability

Compounding the coordination problems among users was the limited tools that could be utilized on flood issues. As the Republic of the Congo is a country that has experienced conflict over the past several decades, only approximately 13 out of the more than 80 historical hydrological gauges are currently operational. Rainfall data is also limited, with information recorded manually and reported once a month from over 15 points around the country (Figure 22).

Notes: (A) Government official from the HydroMet Office comparing the rainfall point data used locally to satellite rainfall data. (B) The reduced number of gauges because of past conflict (top, historical gauge locations; bottom current gauge locations). (C) The manual data collection process for collecting rainfall data.

3. Technical capacity for using satellite-derived information

Beyond the limited tools available, there was also limited capacity for understanding and using publicly available tools that could improve existing processes. Few government ministry officers have staff with appropriate science and engineering training to understand how to use data from satellites, with only the HydroMet Office having this technical capacity. Moreover, slow Internet speeds and low bandwidth further limit the ability to analayse and process such data.

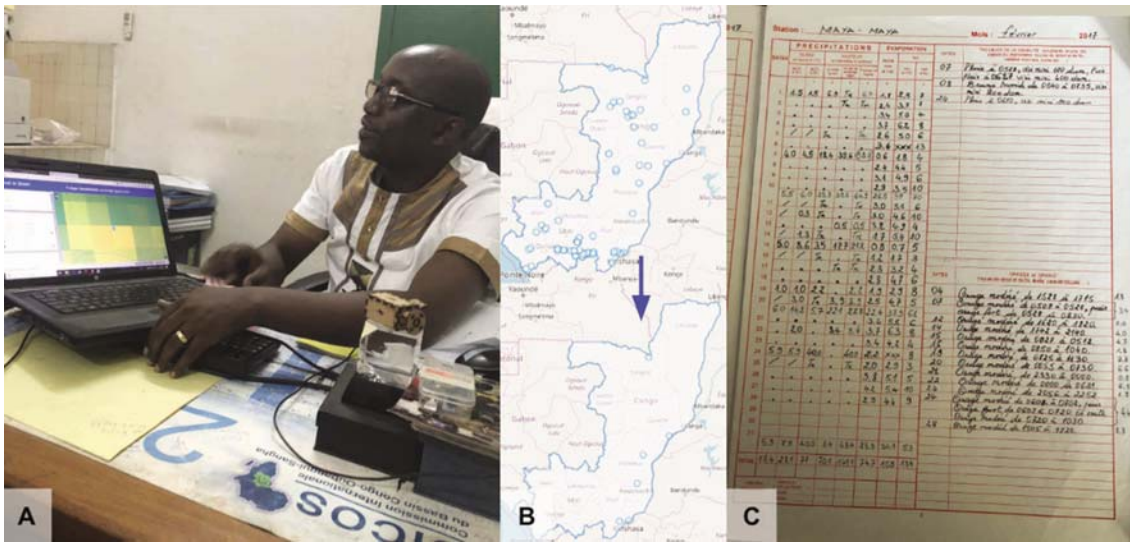

Figure 22: Existing flood information limitations for Republic of the Congo

Conclusions

1. C2S's flood monitoring services identified floods and impacts earlier than would have been identified otherwise by traditional services.
2. C2S was able to respond rapidly and within days to an urgent situation around flood risk for 16 000 refugees.
3. C2S created and facilitated a local WhatsApp group with representation from about a dozen relevant government ministers who used the group to share information and receive daily updates during flooding events.

Contact

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