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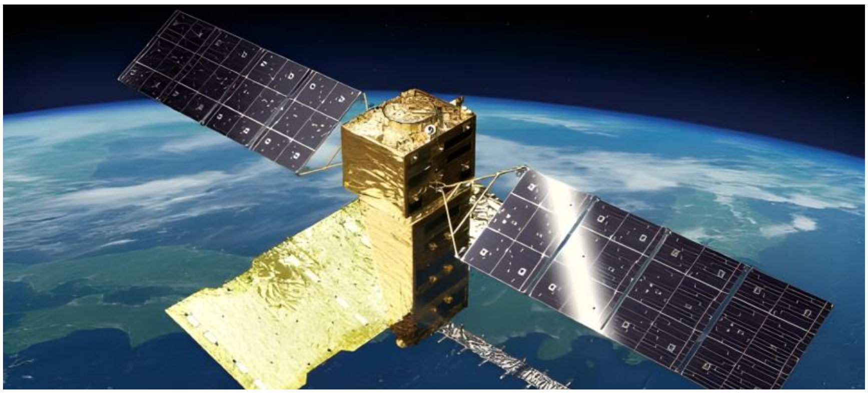
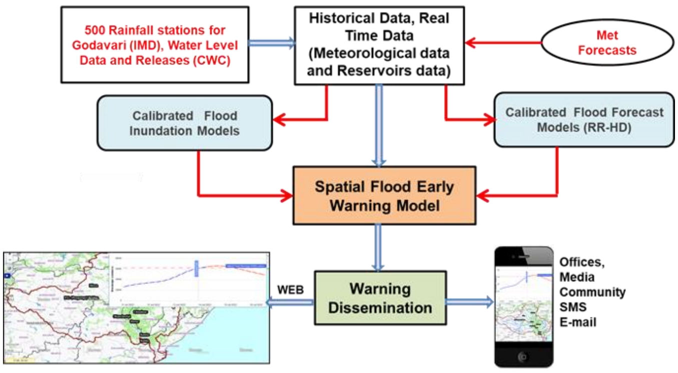
DLR – Charter Leadership

DLR took over the responsibility of the Charter leadership from EUMETSAT and CSA in April 2024 and are handing it over to INPE in October 2024.



JAXA´s ALOS-4

JAXA's newly launched ALOS-4 satellite will support global disaster monitoring through the International Disaster Charter and Sentinel Asia starting in 2025.



Spatial Flood Early Warning Systems

The implementation of this system will help predict floods, enhance preparedness, and reduce potential damage.

SATELLITE DATA TO SUPPORT DISASTER RESPONSE WORLDWIDE

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DLR leads the International Charter: Space and Major Disasters and will soon hand it over to INPE

In April 2024, the German Aerospace Center (DLR) assumed leadership of the International Charter: Space and Major Disasters (the Charter) from the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the Canadian Space Agency (CSA). The DLR will pass on these responsibilities to the Brazilian Instituto Nacional de Pesquisas Espaciais (INPE) during the 52nd Charter board meeting, which will take place in São José dos Campos, Brazil from 9-11 October 2024.

In April 2024, representatives from the Charter's member agencies convened in Bonn, Germany, for a week of discussions on the operations and status of the Charter. Two days were devoted to a training of Emergency on-Call Officers (ECOs). Participants from various space agencies, along with the Charter Executive Secretariat, engaged in sessions that focused on understanding the roles and procedures of ECOs. They also received updates on the Charter's COS-2 system through presentations and practical exercises, using simulated disaster scenarios.

Under the leadership of DLR, there were a total of 44 Charter activations, with the support and collaboration of all Charter members, Authorized Users, Project Managers and other partners. The most covered activation were the floods in Brazil in April, which are featured in this newsletter.

During DLR's lead period, the number of Authorized Users (AUs) grew to 94. New members included the Agence Nationale de Gestion des Urgences et Catastrophes Humanitaires (ANGUCH) in Guinea and the National Emergency Management Agency (NEMA) in New Zealand. Furthermore, National Emergency Management Organisation (NEMO) in St. Vincent and the Grenadines, Kazakhstan Gharysh Sapary (KGS) in Kazakhstan, and the Space Research and Technology Agency under the Ministry of Digital Technologies of Uzbekistan are also in the process of becoming Authorized Users. These additions expanded the Charter's global reach, enabling national disaster management authorities to request emergency support more easily, enhancing the Charter's contribution to international disaster management efforts.

Charter members attending the dinner following the meeting. © DLR

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Data Contributors and Their Role in the International Charter on Space and Major Disasters

The International Charter: Space and Major Disasters

The International Charter on Space and Major Disasters (the Charter) is a collaborative initiative that leverages satellite data to support disaster management efforts globally. Founded by the European Space Agency (ESA), the French Space Agency (CNES), and the Canadian Space Agency (CSA) in 1999 and operational since 2000, the Charter provides rapid access to satellite data during major disasters, enabling governments, NGOs, and relief organizations to coordinate their efforts. Its primary aim is to deliver Earth observation data quickly and efficiently to aid in disaster response and mitigate the impact on affected populations. As of 2024, the Charter is supported by 17 space agencies worldwide.

What is a Data Contributor in the Charter?

A Data Contributor is an organization or entity that provides satellite imagery and geospatial data to the International Charter. These entities supply high-resolution images and other essential data. This data is crucial for assessing damage, planning relief operations, monitoring disaster situations, and supporting decision-making during emergencies.

Key responsibilities of a Data Contributor include:

• Timely Data Provision: Supplying high-quality Earth observation data promptly during disaster events. The data must be operationally relevant and accessible in near real-time to be effective for emergency management.

• Data Accessibility: Ensuring that the data is easily accessible and compatible with the Charter’s systems, facilitating seamless integration into disaster response workflows.

• Supporting Analysis: Collaborating with Charter members to interpret and analyze the data, contributing to the production of maps and reports that aid in disaster relief and recovery operations.

How Data Contributors Support the Charter

Data Contributors enhance the Charter's capabilities by providing a diverse range of satellite data, including optical, radar, and thermal imagery. This data is crucial for various phases of disaster management, from immediate response to damage assessment. Contributors support the Charter by:

• Improving Coverage: Expanding the geographical coverage and types of data available for disaster monitoring, ensuring the Charter can respond effectively to disasters worldwide.

• Increasing Data Frequency: Providing frequent updates through rapid revisit times, which is essential for tracking the progression of dynamic disasters like floods, wildfires, or hurricanes.

• Enhancing Data Diversity: Offering various types of Earth observation data (e.g., radar, optical, and thermal), which helps analyze different aspects of disasters, such as structural damage, water levels, and thermal anomalies.

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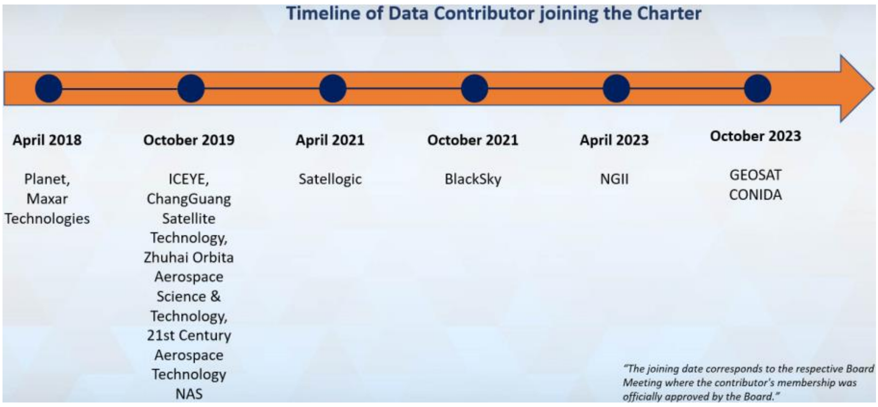
Process of Becoming a Data Contributor

To become a Data Contributor for the International Charter, an Earth observation data provider must undergo a specific application and approval process. The provider submits an application detailing their capabilities, including satellite systems, data types, and readiness. Sample data is submitted and evaluated for quality and compatibility. If approved, the provider is integrated into the Charter's workflow or authorized as a third-party supplier. Ongoing collaboration ensures the continuous availability of high-quality data during disasters.

Specific Data Contributors and Their Roles

The International Charter greatly relies on the following key Data Contributors, each providing unique capabilities essential for effective disaster management. Data Contributors enhance the Charter's capabilities by providing a diverse range of satellite data, including optical, radar, and thermal imagery. In addition to the satellite data provided by Charter Members, these Data Contributors play a vital role in ensuring a comprehensive data supply. This data is crucial for various phases of disaster management, from immediate response to damage assessment. Strictly speaking, the Charter does not engage in recovery activities. Contributors support the Charter by providing timely and accurate information, enabling emergency responders to make informed decisions and effectively address disaster impacts. The following is a list of the current Data Contributors for the Charter:



Timeline of Data Contributor joining the Charter. © DLR

JAXA´s News Radar Satellite "ALOS-4" will contribute to the Charter

JAXA launched its new satellite, "Advanced Land Observing Satellite-4 (ALOS-4)," or "DAICHI-4," onboard the third H3 Launch Vehicle from the Tanegashima Space Center on July 1, 2024 (JST). This new satellite carries L-band Synthetic Aperture Radar (SAR), like its predecessor "ALOS-2" but with enhanced capability. Although the resolution is the same as that of ALOS-2, the swath of ALOS-4 is much wider, allowing it to observe a much larger area of the surface of the Earth in a single acquisition. Its swath is 200 km with 3 m, 6 m, and 10 m resolution in Stripmap mode, and 700 km with 25 m resolution in ScanSAR mode. The satellite entered the initial functional verification operations phase of about 3 months to confirm the functionality of its onboard equipment. From 2025, ALOS-4 will move into the nominal phase and start providing data. ALOS-4 will contribute to both the International Disaster Charter and Sentinel Asia by taking advantage of these merits to observe and monitor disasters worldwide including in the Asia-Pacific region.

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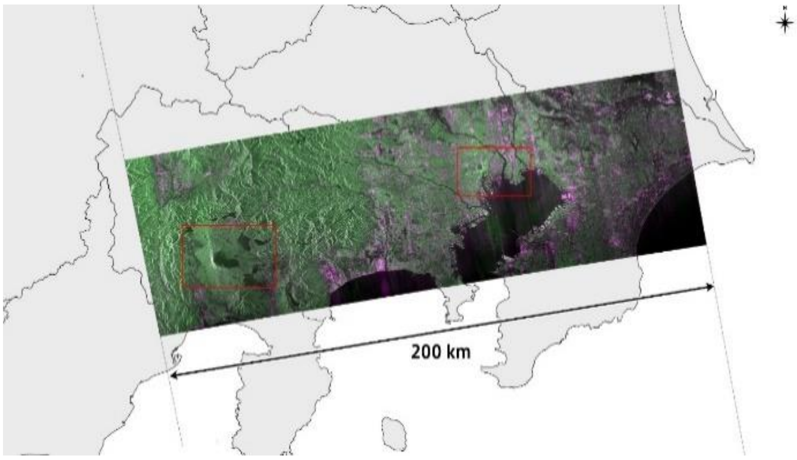


First image collected by ALOS-4 (Mt. Fuji area) © JAXA

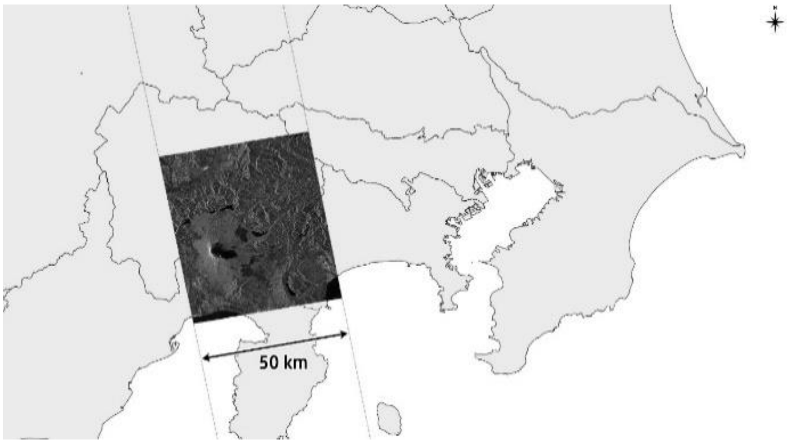
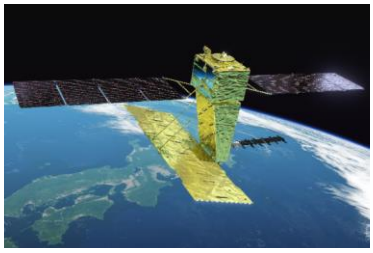


Image collected by ALOS-2 (Mt. Fuji area) © JAXA



© JAXA

Emergency On-Call Officer Training in Bonn

The Emergency On-Call Officer (ECO) training event was held at the University Club Bonn in the frame of the 51th Charter meeting in Bonn, Germany. The two-day training was organized and moderated by DLR representatives of the International Charter "Space and Major Disasters".

The training began on the 22th of April, 2024. The attendees were ECOs from CNES, Airbus, ESA, CNSA, and DLR as well as representatives from the Charter Executive Secretariat.

The first day focused on introductions, where the objectives of the meeting were presented by DLR. Following presentations focused on the Charter ECO role and procedures given by ESA, the different disaster scenarios covered by the Charter (DLR), information on new satellites in the Charter, lessons learnt from anomaly reports and the last two ECO Semi Annual Refresher Exercises (DLR/UKSA) as well as on updates to the new Charter Operational System (COS-2) with respect to the ECO duties (EVERSIS). A discussion session on the ECO role and on COS-2 concluded day one.

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For the second day of the training, the participants were divided into several working groups of 2-3 persons to perform hands-on trainings using COS-2. Two training scenarios with fictitious crisis situations were set up in advance in COS-2 by DLR. Scenario 1 focused on an oil spill event near the island of Ventotene, Italy. Scenario 2 was related to a flood situation and a cascading landslide event in Southern Germany along river Isar. During the training session DLR acted as Authorized User (AU) of the respective Charter activation in order to train the important step of the interaction between the ECO and the AU. After completion of the exercises, the groups were given time to prepare a short presentation of their results and feedback from their experience. Finally, recommendations of the training regarding improving the role of the ECO were formulated and presented by DLR on the same day during the Charter Executive Secretariat meeting.

Attendees of the ECO meeting. © DLR

Unprecedented flood in Brazil

An intense and striking flood took place in Brazil during the months of April and May, 2024, affecting thousands of families mostly in the Guaiba river basin, located in the state of Rio Grande do Sul.

From a single remote sensing image obtained by the CBERS-4 satellite, one could see an overwhelming disaster emerging on an extensive number of Rio Grande do Sul major water basins.

The state of Rio Grande do Sul has a total area of more than 281,000 km² and the image observed around 160,000 km². It captured an area approximately 400 km wide, from the eastern region to the coast of Rio Grande do Sul, and 400 km high. The image shows the flooding of the main basins triggered by the extreme rainfall, in areas such as the Jacuí, Caí and Taquari, in addition to the Pardo, Sinos and Guaíba river basins.

The International Charter: Space and Major Disasters was activated on April 30, 2024 by CENAD (National Center for Risk and Disaster Management - institution responsible for managing information on risks, alerts and response actions in Brazil). The activation - The Charter´s 875th - lasted 51 days, and involved 43 areas of interest (AOI) which covered as far as 600 km from East to West and 340 km from North to South. Satellite data acquired through the Charter was used to aid search, recovery and rescue operations, and helped assess damage caused by the flood.

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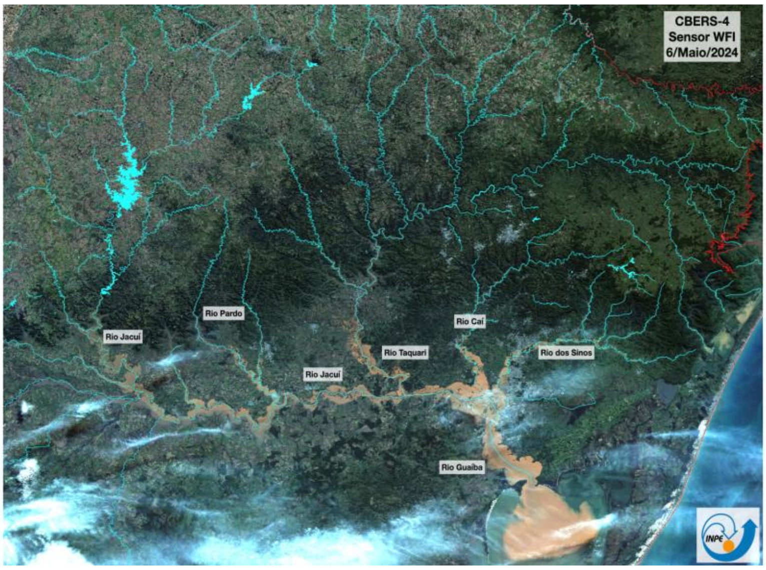

Remote Sensing image from CBERS-4 WFI Sensor, showing parts of the overwhelming disaster emerging on an extensive number of Rio Grande do Sul major water basins. © INPE

The flooded area was enormous, affecting more than 25% of the population of the state of Rio Grande do Sul (around 2.5 million people). The flood caused the loss of more than 170 human lives as well as many animal lives. The torrential rain, flooding and subsequent landslides caused countless structural and agricultural damages, leading many residents of the region to be displaced.

The Project Manager for the activation was Arthur Matos from the Brazilian Geological Survey, an institution registered in the International Charter as an End User. The team was composed of 17 Value adders from 9 different institutions who provided a total of 136 Value Added Products (VAPs). These VAPs used approximately 150 individual satellite images, out of a total of 1398 images provided for the Activation. A vast majority of the VAPs (122) were delivered within two weeks of the disaster, and another 14 were produced later for compliance with requests for financial assistance. Due to cloud cover, the first VAPs used Synthetic Aperture Radar (SAR) images, to provide a rough and quick estimate of the affected areas. A total of 370 municipalities (out of the 497 in the area) were affected to some degree by floods and landslides.

The importance and extent of the damage caused by extreme weather events is huge, as are the terrible and destructive results they bring to the local population. Concerted efforts, such as the international cooperation of the Charter, provide valuable help and support to those affected by such large events. Observations from space help disaster response organisations on the ground to mitigate the damage and promote the recovery of the affected areas.

The increased frequency and intensity of extreme events, as predicted by scientists, shows how essential the work of the International Charter is, which can call upon imagery from a virtual constellation of more than 270 satellites around the world.

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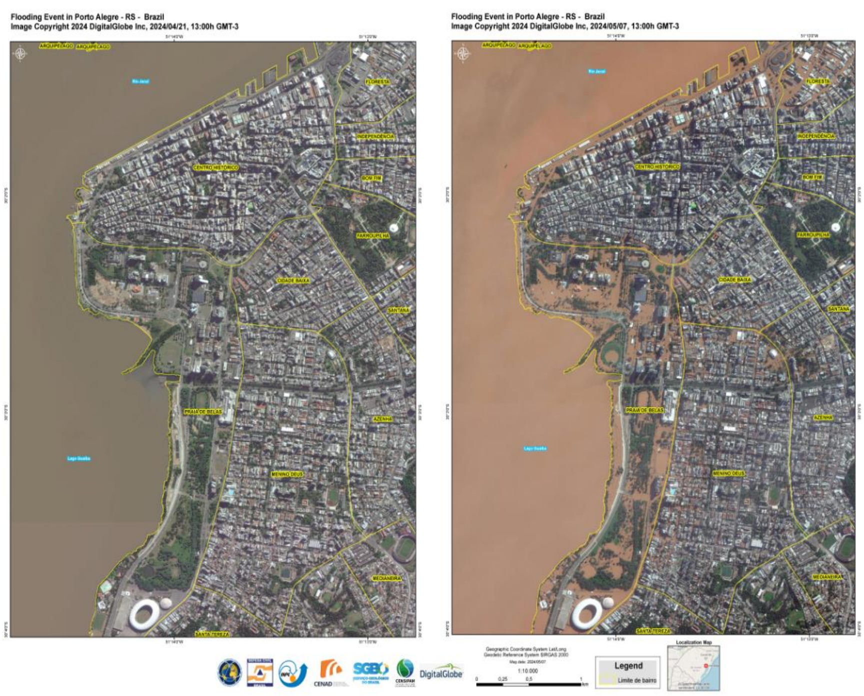

Value Added Product (WorldView image) showing extensive flooding in Porto Alegre, capital of Rio Grande do Sul (https://disasterscharter.org/image/journal/article.jpg?img_id=24820980&t=1715788625607) © INPE

Spatial Flood Early Warning Systems - Best Practices in Flood Risk Management

Floods are among the most frequent and devastating natural disasters, causing widespread damage to infrastructure, property, and human lives. Effective disaster risk management (DRM) for floods requires a comprehensive understanding of the mechanisms that govern flood events, as well as the ability to predict, monitor, and respond effectively. A key component in this effort is the implementation of Spatial Flood Early Warning Systems (EWS), which leverage advancements in geospatial technologies, modeling techniques, remote sensing, and data analytics to forecast flood events and issue timely warnings. These systems are critical not only for mitigating the immediate impacts of flooding but also for supporting long-term resilience and adaptation strategies.

The development of medium-range spatial flood early warning models for large catchments, such as the Godavari Basin in India, presents a considerable challenge. Recognizing the national importance of such efforts, the Indian Space Research Organisation (ISRO) has developed spatial flood early warning systems for the Godavari Basin using space-based inputs. These models have been meticulously calibrated and validated with historical discharge and rainfall data provided by the Central Water Commission (CWC) and the India Meteorological Department (IMD). The use of very high-resolution Digital Terrain Models (DTM) in spatial flood early warning models represents a significant advancement in flood risk management. This technology enables the generation of spatial flood alarms prior to flood events, offering sufficient lead time for preventive measures. The developed web-enabled fully automated spatial early warning systems being run on operational basis in real-time with data support from CWC and IMD. The results are disseminated through the National Database for Emergency Management geoportal of ISRO.

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One of the key innovations in this field is the integration of reservoir operations and the use of very high-resolution Digital Terrain Models (ALTM DTM) in spatial flood early warning systems. Additionally, these advanced systems are designed to operate autonomously, minimizing the need for manual intervention. These innovations greatly enhance flood forecasting and management, offering a deeper understanding of floods and improving community preparedness and mitigation.

Integrated Modeling Framework

Landuse/Landcover, Soil Textural information and digital elevation model of the complete basin was used in deriving topographic and hydraulic parameters. Historical daily rainfall data from IMD and discharge data from CWC for various gauge stations were used to develop a real-time operational flood early warning model. The Flood Forecast Model was meticulously calibrated over five years and validated over three years. Spatial inundation models were set up using very high-resolution DTM (ALTM DTM), and calibrated and validated for different flood events. Hydrological and hydrodynamic models were integrated in 1D& 2D coupling framework as shown in figure 1.

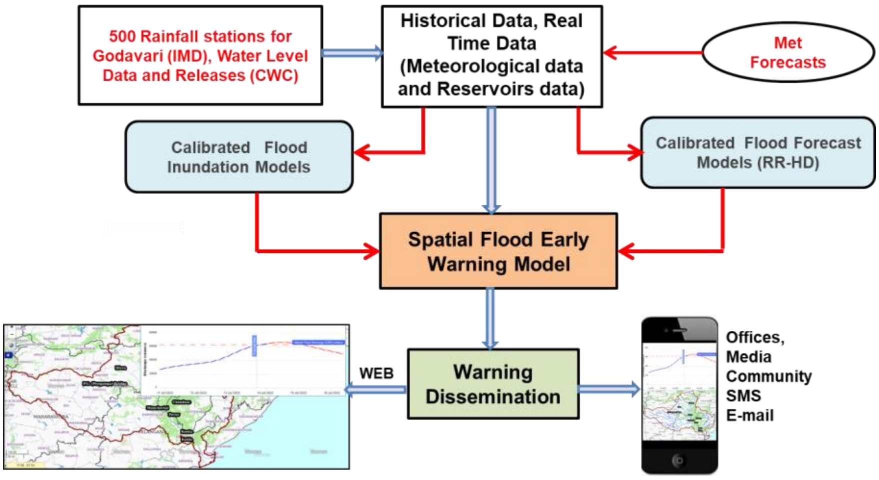

Figure 1: Integrated Modeling Framework of Spatial Flood Early Warning System. © ISRO

The flood discharge forecast accuracy exceeded 85%, with a lead time of 36 ro 50 hours from upstream to downstream stations. The inundation simulation accuracy, based on ALTM DTM, was also found to be greater than 80%. These improvements in forecasting accuracy and lead time extending to two days or more are instrumental in providing more reliable flood discharge computations in the spatial domain.

Real-time Operation of Spatial Flood Early Warning System

The spatial flood early warning models for the Godavari Basin, operational since 2022, have demonstrated significant utility during flood events. These models operate in real-time, leveraging field rainfall data of about 500 gauge stations from the India Meteorological Department (IMD) as well as rainfall forecasts from the IMD Weather Research and Forecasting (WRF) model. The generated flood alerts were disseminated through the NDEM Geoportal and being disseminated to the concerned user organisations. Computed flood forecast hydrograph during July 2024 floods is shown in the figure 2. Spatial flood inundation simulation simulated using very high resolution DTM is shown in the figure 3.

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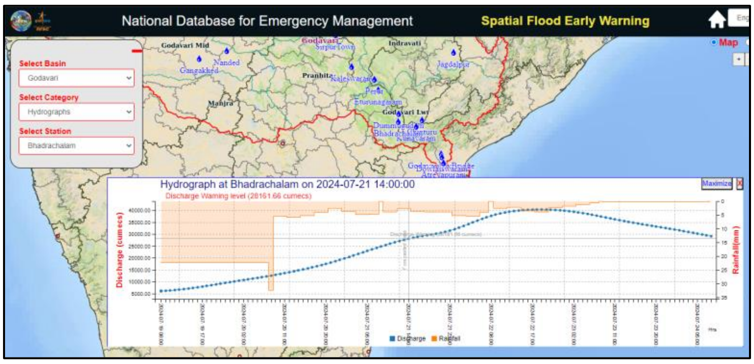

Figure 2: Flood forecast for Godavari River at Bhadrachalam station (21 July-2024). © ISRO

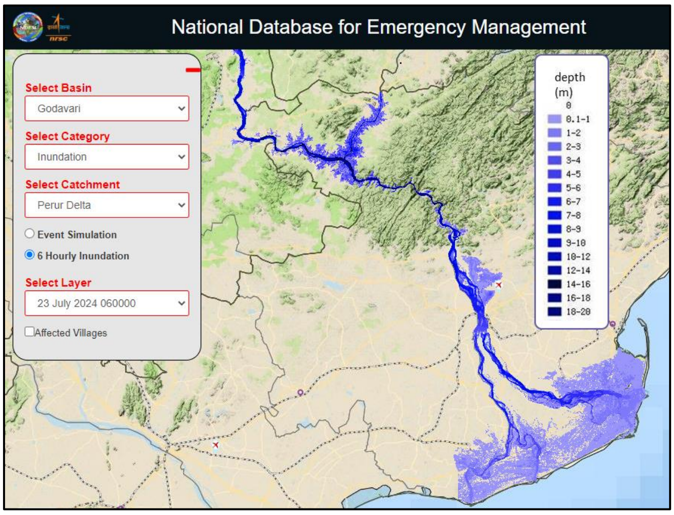

Figure 3: Flood inundation forecast for 23rd July 2024 flood event in Godavari River. © ISRO

Village administrative layers are overlaid with flood inundation simulations in NDEM in real-time to predict the villages that are going to be affected, time of inundation, and depth of inundation and shown in the figure 4.

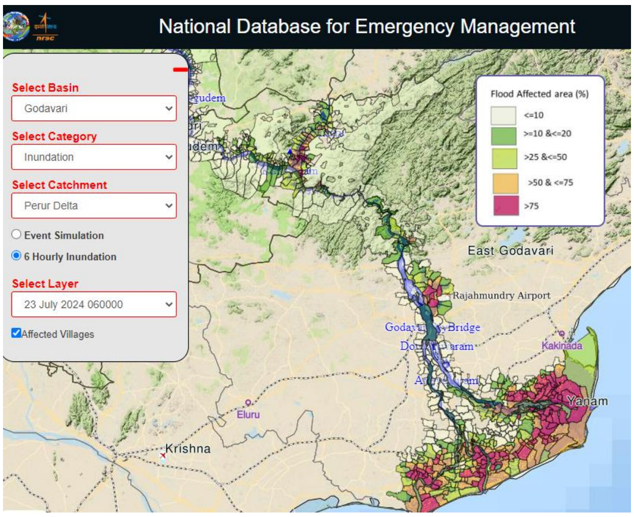

Figure 4: Villages that were going to be affected due to forecasted flood inundation during July 2024 flood event. © ISRO

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Societal Benefits: Spatial flood early warning systems significantly enhance societal resilience by providing timely and accurate flood predictions, enabling early evacuations and targeted protective measures. They improve disaster preparedness, allowing authorities to allocate resources effectively and coordinate response efforts efficiently. These systems also contribute to long-term resilience by informing urban planning and infrastructure development, thereby reducing future flood risks. Economic benefits include reduced disruption and damage costs, while accessible risk information increases public awareness and preparedness. Overall, these systems are crucial in mitigating the impacts of floods.

The Evolution of the ESA Charter Mapper

To better support Charter Project Managers (PM) and Value Adders (VA) in the context of activations, the Charter Operational System (COS-2) has been augmented with a processing environment dedicated to satellite imagery called the Charter Mapper. It eases the access and the usage of EO data acquired during an activation with a set of tools to visualize and process satellite imagery on-line. EO data received from the Charter members and partners through COS-2 are automatically ingested and transformed into full-resolution EO images ready for analysis.

The Charter Mapper is built with state-of-the-art technology (Kubernetes, TiTiler, SpatioTemporal Asset Catalog, OGC Application Package), supports a broad range of radar and optical imagery from 40 EO missions (24 space agencies and data distributors), and thanks to a scalable cloud engine, it guarantees the massive cloud processing required to handle large volumes of EO data sent for each Charter activation. Since the operational deployment of the Charter Mapper in September 2021, about 48,000 acquisitions from 164 Charter activations have been ingested in the system, resulting in over 200 TB of data stored. With the Charter Mapper, PMs and VAs can access process-ready EO data, browse satellite imagery at full resolution to filter and select images of interest, and carry out visual analysis. Furthermore, users can also apply GIS functionalities and perform EO-based processing to extract geo-information from satellite imagery. As an example, PM/VAs can use the ESA Charter Mapper to create ad-hoc composites of different spectral bands, optimizing the signal to the hazard type, allowing them to observe changes across time as the activation develops.

New Processing Service: HASARD Single Image

The HASARD Single Image service, designed by the Luxembourg Institute of Science and Technology (LIST), generates a binary mask of standing water from a single radar backscatter image. This mask helps identify potential flood-affected regions using data from multiple satellite missions, including Sentinel-1, RCM, TerraSAR-X, TanDEM-X, and SAOCOM-1. The input of the service is a co-pol Sigma Nought single band asset (radar backscatter image) and the HAND (Height Above the Nearest Drainage) auxiliary dataset, which helps exclude false positives in sloped areas. This service was introduced at the beginning of 2024 to allow users to take advantage of high-resolution post-event radar datasets, which are not often accompanied by archive reference images. This service augments the potential for radar processing on the platform, as the original HASARD Dual image service requires both pre- and post-event images from the same orbit, making it compatible only with missions acquiring images systematically, e.g., Sentinel-1. The result generated from the Single Image service can be then coupled with the STACK service and ESA WorldCover Auxiliary product to remove permanent water bodies. The resulting raster is a mask of satellite detected standing waters located in areas not recognized as permanent water bodies (i.e seas, oceans, lakes, rivers, or wetlands).

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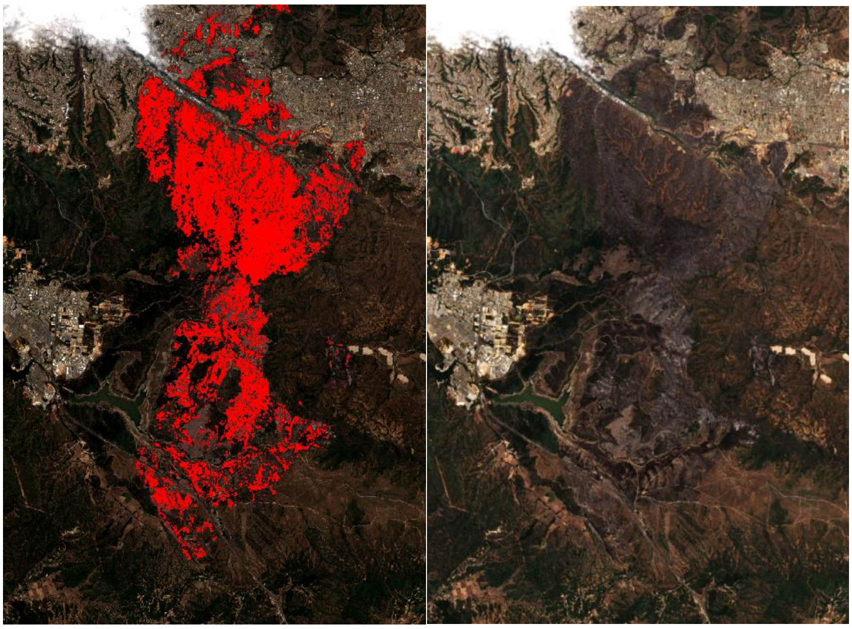
New Optical Index: Burned Area Product – Wildfire Damage Mapping

To support the Charter Project Managers and Value Adders in estimating burned areas, a dedicated algorithm is included in the Optical Calibration chain to derive the Burned Area Product (BAP). The BAP algorithm is systematically applied to optical EO data having at least blue, green, nir, swir16, and swir22 spectral bands (currently only Sentinel-2 and Landsat-8/9). The script does well at detecting burned areas and covers burned land well in most cases. The script is not perfect, as it sometimes fails to completely cover the burned area or overestimate them. It is however useful for detecting burned areas nonetheless, as it consistently detects large scale recently burned areas.

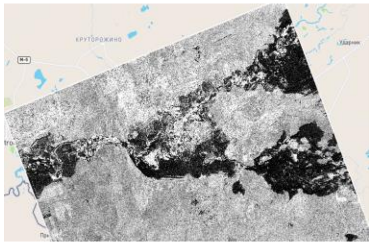
The product is useful for quickly identifying images containing burned areas as well as monitoring the changes in burned areas over a time series of several images. This product complements the existing Burned Area Severity (BAS) service (which requires pre- and post-event images) in that it can provide an estimation of burned area without a reference image.

In the example below, comparing the BAP index with the original image over Valparaíso, Chile, we can see that the automated single scene algorithm matches well with the visible burned area in the Sentinel-2 image. The post-event Sentinel-2 image used is from Feb 7th, 2024, acquired for Act-859: Wildfires in Chile.

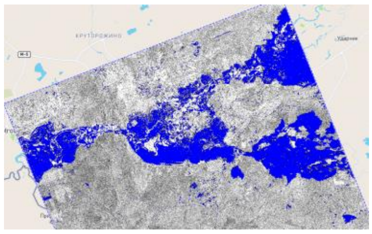


BAP (left) compared to source S-2 image (right). © ESA

The image below shows a Value Added Product generated by the Copernicus Emergency Management Service for this activation (Act-859 Wildfires in Chile). The VAP is over the same location as the BAP overview shown above, it can be seen that the shape of the burned area is very similar, indicating the relative accuracy of the Burned area Product.



Example of the HASARD SI Service in Act-871 Flood in Russia. Gaofen-3 post event scene (top) with HASARD single scene result (bottom) © ESA



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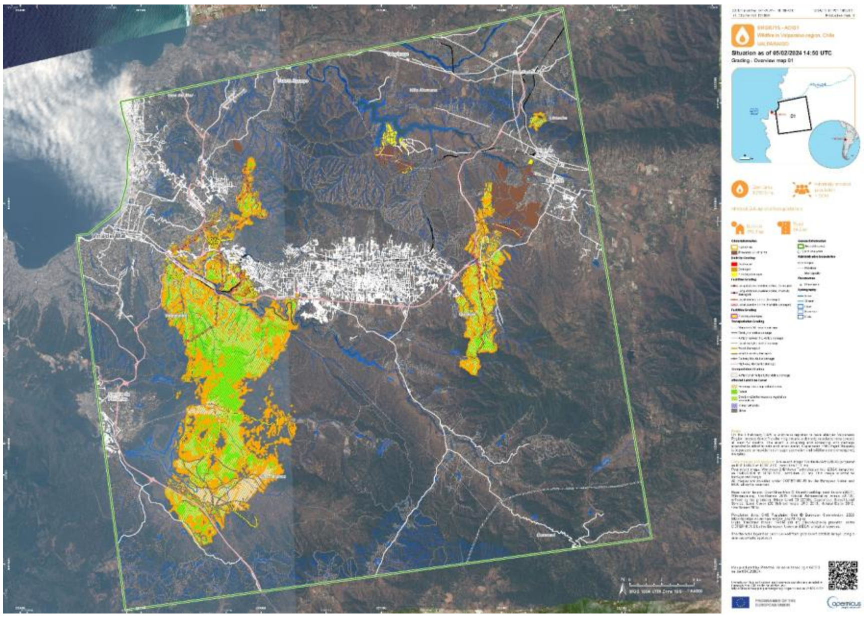

VAP generated by CEMS for Act-859 over Valparaiso, Chile. © ESA

Generating Results on the Platform

The user base of the ESA Charter Mapper continues to grow as new users are trained on its functionalities. ESA regularly contacts Project Managers and Value Adders to offer online training of the platform, which has helped to mitigate the difficulties faced by new users. While Value Added Products (VAPs) are often generated using the preferred processing method of the user, results which are suitable for VAPs can be generated within the Charter Mapper. This was exemplified by Zachary Foltz from ACRI-ST, who used the Charter Mapper to generate results used in VAPs for Activation 883: Flood in Colombia, and for Activation 885: Landslide in Papua New Guinea. The product generated for Act-883 was simply a pan sharpened post-event WorldView image, processed using the PAN-SHARP service. Pan sharpening the image allowed for the visualization of more detailed features of the landslide. For Act-883, the product was a flood extent map generated using the HASARD Single Image service to process a TerraSAR-X acquisition. Permanent water bodies were removed, and the final result was downloaded and subsequently uploaded to QGIS to create the final product. “The Charter Mapper allows for the rapid retrieval of valuable geoinformation, allowing even those with limited experience processing data to generate meaningful products” said Zachary, who has been a PM and VA for several activations since 2022. Another quote came from Dalia Laoubi of CSA, who has been a frequent Value Adder since 2023, “I benefit from the advanced tools provided by this platform to develop value-added products during Charter activations. This platform enables me to assess the extent of disasters using radar imagery from the RCM constellation. With the various available applications, such as HASARD Single Image and Co-located stacking, I can evaluate the magnitude of damage over time. For example, these tools allow for the detection of potential sources of flooding, as seen in the case of Cyclone Gamane at the end of March [Act-870], which caused significant flooding in the affected areas. The ongoing development of these applications is highly notable, enhancing their utility and ensuring they remain essential tools in disaster response efforts.” The ESA team looks to continue its promotion of the mapper to ensure users are aware of its capabilities and have the capacity to generate useful products.

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