OPEN GEOSPATIAL CONSORTIUM

OGC Disaster Pilot:

Integration of state-of-the-art technologies for multi-hazard analysis and disaster response

An OGC Innovation Program Initiative, v2.2 / August 2020

OGC®
Making location count.

1. Vision

The disaster strikes. Urgently, disaster relief forces access data from multiple sources that can be integrated and analyzed quickly. The relief forces process the data and apply Artificial Intelligence and simulation models to distill the relevant information. Essential information is extracted based on machine learning techniques from satellite imagery. All processing takes place on cloud platforms; right next to the physical location of the data. Data transfer is minimized. All information is presented in a directly consumable and actionable way. In disaster scenarios, network availability is often an issue. Still, the right information needs to be presented at the right time in the right way - even offline.

This OGC Pilot brings all the above-mentioned technologies together. Though elements have been explored and tested in various scenarios, it is the OGC's unique position in the center of the geospatial marketplace that allows a single pilot exploring and testing key state-of-the art technologies in yet unprecedented way. This initiative will uncover the market capacities and capabilities and serve as an accelerated market research activity, while at the same time demonstrating the integration potential native to OGC Innovation Program activities.

2. Thematic Background

At an increasing frequency, multiple jurisdictions across expansive regions are facing major disaster events, including wildfires, coastal and urban flooding, disease outbreaks, extended drought, landslides, hurricanes, earthquakes, or pandemics.

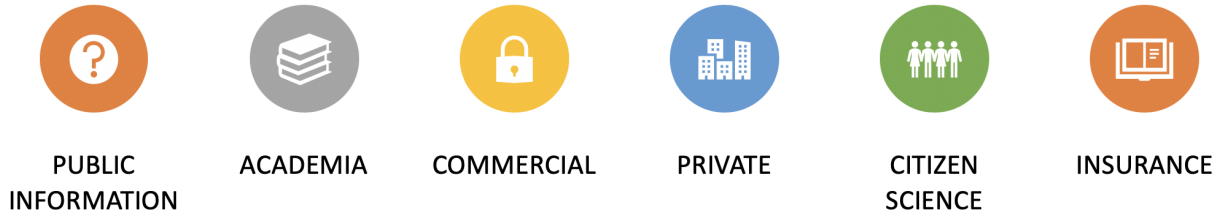
These events pose serious threats to the economy, environment, infrastructure, private property, or public health, as well as public and commercial services.

Many local, national, tribal, provincial, and regional jurisdictions have adopted common Spatial Data Infrastructure (SDI) policies and best practices to support the sharing and exploitation of important location information and to support rapid adoption of new geoinformation sources and technologies. However, these policies and practices are inconsistently implemented, which has limited the ability of valuable information and tools to be shared and used to address critical challenges such as disasters.

Several recurring challenges have been identified as areas needing worked based on the Disasters Resilience Pilot and Concept Development Study.

- The End User of the geospatial data is often overwhelmed by the total amount of data being delivered, often to the point of the data being useless. This “firehose” of data is often not used. What is needed is for the End User to have the correct and timely information strategically delivered to him/her, based on the End User needs.

- Inability to properly fuse / synthesize multiple data sources locally to derive knowledge necessary for rapid disaster response decisions. Many organizations still do not use standards to facilitate easy sharing of information.



- Poor metadata leading to an Inability of existing discovery approaches to quickly understand which information sources are most useful in the context of a User’s need such as in a disaster event

- Absence of a persistent platform to organize and manage disaster-related geospatial information and tools necessary for collaborating organizations. Sites might be down or unreliable during the emergency and thus cannot be depended upon. Limited bandwidth may require pre-positioning of major datasets prior to deployment of teams into the field.

SOCIAL ECONOMIC ENVIRONMENTAL ANALYSIS READY DATA REALTIME TIME SERIES

Important geospatial assets related to disaster events seem rarely to be managed in a way that assures access to all players in disaster events, and data is not retained in a persistent environment to support the full lifecycle of a disaster event. Clearinghouse assets do exist to support such a function but are not as of yet employed to address the full disaster lifecycle. Challenges related to geospatial information discovery, management, sharing and usage experienced at the local level are also an area of concern at the national level as noted in comments from leadership of the US GeoPlatform during the 2018 Disasters Resilience Pilot:

"*Today, government workers, citizens, industry, and academia face large volumes of distributed, diverse geospatial data, and services that lack logical consistency and coherence (machine-understandability). It is often difficult to find and exploit data on-demand for timely decision making. Most geospatial data, applications, and services are bottled up in enterprise silos and vendor-dependent technology stacks, which may meet the needs of select internal users, but these resources are not readily available to all who have the need for access. Cross-enterprise interoperability and collaboration capabilities are limited. The nation also has too few reliable, authentically open (e.g., OGC-compliant), interoperable services for users to exploit on-demand from their point of need. As such, users often resort to costly, labor-intensive, error-prone, and time- consuming data file sharing procedures, resulting in redundant, out-of-date, and hard-to-find copies of data.*

Users spend too much time searching, copying, re-formatting, and trying to understand data provided by others. When they find it, they often discover that, while the data may meet the most basic needs for human understanding and use (and even this is often a struggle), it usually falls well short of meeting the requirements for direct machine processing and application. Thus, the potential for machine-to-machine automation and enhanced user productivity is greatly reduced. Users carry far too much of the burden for

finding, copying and munging data, rather than understanding, deciding, and acting upon data. Furthermore, geospatial data must also come out of its silos, and be better integrated with non-geospatial data, to increase its value and relevance to the mission.

Better shared cyber-infrastructure and shared services are needed for the nation to overcome the obstacles. GeoPlatform addresses this need."

The GeoPlatform in the United States, the CDGI platform in Canada, and similar platforms maintained by other nations and jurisdictions offer opportunity to align and unite disaster data, tools, and analysis over the complete disaster lifecycle – not only in support of preparation and response, but also to support long term coordination, assessment, and accountability related to recovery, which can often take months to years.

3. OGC and Spatial Data Infrastructures for Disaster Resilience

The OGC Spatial Data Infrastructures for Disaster Resilience initiative was initiated in 2018 to understand how to best support the development of, or combination of SDI(s) for the use in disasters, to advance the understanding of stakeholder issues, and serve stakeholders' needs. The study included stakeholder engagements, workshops and open Request for Information (RFI) that gathered local, national, and global perspectives to understand user needs and gaps on the optimal setup and design of an SDI for disasters. The OGC Development of Disaster Spatial Data Infrastructures for Disaster Resilience report describes the various types of stakeholders of an SDI for disasters with their specific needs and requirements on aspects such as data sharing, standards & interoperability, funding and investment, integration with existing systems, architecture and platform as well as security, privacy, and safety. The report further presents various architecture models with a focus on standards required to optimize discovery, usage, and processing of data in a highly heterogeneous network of SDI data and service providers. The report concludes with several demonstration scenarios that could be used in subsequent pilots to demonstrate the value of an SDI for disasters to a broad range of stakeholders in different types of disasters. The community supported the concept of pilots to address user gaps and needs.

Per the recommendation of the study, OGC kicked off the first OGC Disasters Resilience Pilot in 2019 focusing on gaps and needs related to discovery, access, usage and processing of data using a variety of standards and technologies. This resulted in 15 national and international public-private implementations leveraging existing and emerging geospatial capabilities to address social, economic and

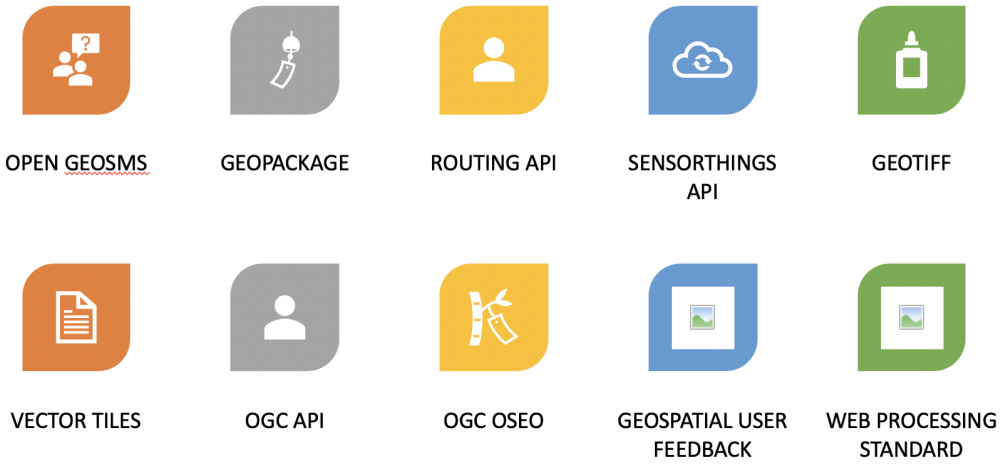
environmental challenges related to hurricanes, wildfire, landslides, extreme storms, floods, public health, and other topics. The pilot efforts increased understanding of the challenges in discovering, accessing and using geospatial information, delivered applications, tools, lessons learned, best practices and user guides to begin to address identified gaps.

From the technical perspective, OGC has been addressing the Disaster response and preparedness vision from different perspectives: In 2018, OGC looked at the integration of Artificial Intelligence/Machine Learning models and location data. At the same time, a new architecture was designed to fully exploit the potential of the "application-to-the-data" paradigm. This architecture has been further refined in 2019 and tested in operational environments this year. The architecture allows the deployment and safe execution of any type of application in distributed and externally operated cloud environments. Complex feature extraction and simulation models have been demonstrated to run on external cloud platforms. High performances have been measured by leveraging cloud-native scalability functions. In 2019 as part of OGC initiative Testbed-15, this work was continued to automatically detect features from satellite imagery using Artificial Intelligence; again deployed and executed in externally provided cloud environments. Testbed-15 further looked into online-offline scenarios with intermittent network synchronization and developed the open portrayal framework for consistent styling of geospatial data in online and offline scenarios. This year, the Earth Observation Application Pilot evaluates the maturity of the new architecture that allows the deployment and execution of applications on cloud platforms. Several other OGC Innovation Program activities produced best practices for data provisioning and GeoPackage production or explored the usage of OGC APIs for data discovery and access. The OGC Disaster Pilot is now an opportunity to test the flow end to end with an emphasis on the missing piece to-date: the end user; the first responder. For that reason, the pilot focuses on two essential elements: First, the provisioning, analysis, and visualization of the right information at the right time featuring a broad set of state-of-the-art technologies such as artificial intelligence and machine learning, cloud processing, containerization of applications for external deployment and execution, feature extraction from live sensor streams, and online/offline support to allow taking all relevant information into the field.

4. Purpose

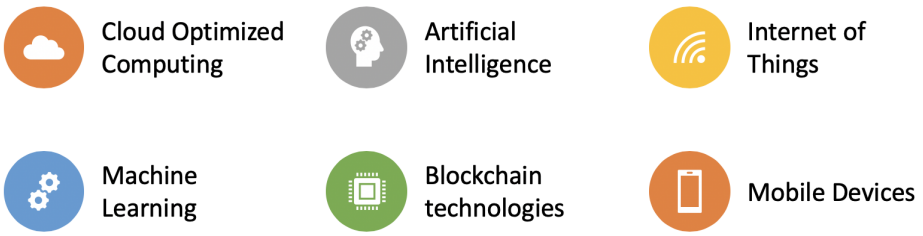
This proposal presents the Open Geospatial Consortium's (OGC) approach for improving responsiveness and providing the appropriate information based on geospatial information to different key individuals for disaster events. The Pilot will focus on improving the ability of key decision makers and responders to discover, manage, access, qualify, share, and exploit location-based information in support of disaster

preparedness and response and multi-hazard risk analysis. This pilot will demonstrate an end-to-end service that integrates OGC standards, data, services, and state-of-the-art technologies into solutions that facilitate disaster response. The following figure illustrates a number of existing and emerging standards that play an important role in the context of disasters.



Emphasis will be placed on learning from the challenges experienced during the Disasters Resilience Pilot and Concept Development Study, leveraging standards-based interoperability, and emphasizing the delivery of geospatial information to primarily support the disaster/multi-hazard planning and response portion of the life cycle that includes short to long-term monitoring, analysis, and assessment for improved understanding of progress and accountability. For the Disasters Pilot, the emphasis will be on working with specific disasters stakeholders in a true operational scenario. The Participants of the Pilot will need to work closely with these stakeholders to ensure the right information is provided to the right person at the right time.

Emphasis will be applied on use of geospatial data from the public and private sectors, existing and enhanced geospatial clearinghouse platforms, and location-based technologies in the context of an interoperable, standards-based framework to assure rapid mobilization of new data sources and tools, as needed.



As illustrated in the figure above, this pilot will make use of the following technologies and recently developed standards will be explored:

- "Applications to the data" architecture with applications packaged, deployed, and executed in software containers on cloud platforms;
- Cloud platforms providing sensor data, Earth observation data, Internet of Things data, and processing capacities to allow execution of the containerized applications;
- Machine learning and artificial intelligence based feature extraction tools packaged and containerized as applications;
- Simulation models dynamically parameterized and executed to provide additional forecast data;
- GeoPackages and other offline containers to ensure support for both online and offline scenarios;
- Portrayal frameworks for consistent visualization of involved data and blockchain for data integrity.

All too often, local, regional, tribal, provincial, and national authorities are unable to accept, exploit, and benefit from the variety of geoinformation sources available to them during a disaster event. While Spatial Data Infrastructure (SDI) policies are in place in many jurisdictions, there is often an overwhelming volume of information available in inappropriate format, and information that is delivered too late. A lack of clarity also exists in those policies with respect to coordination, qualification, and acceptance of external geoinformation due to lack of metadata and associated IT tools, all of which result in missed opportunities and heightens potential loss of life, property, and infrastructure.

5. Proposal Objectives

This Pilot will use different techniques described below to improve advanced planning and response for flooding and wildland fire events that can greatly improve the ability of End Users to address different situations.

This Pilot will explore Machine Learning (ML) techniques to improve advanced planning for wildland fire and flooding events that can greatly improve the ability of first responders to address specific situations. The use of ML is currently a focus of the OGC Testbed-16. Though the current Testbed-16 uses a wildland fire scenario, the emphasis is not on the quality of the modeled results, but on the integration of externally provided source and training data, the deployment of the ML model on remote clouds through a standardized interface, and the visualization of model output. This Operational Exercise will dovetail with

the current work by taking the output from the Testbed and applying the technology created in a real operational use case.

This initiative will also focus on the use of Analysis Ready Data (ARD). As noted in the Testbed-16 Call for Participation, Analysis Ready Data is a powerful concept which lacks a common definition. The ARD concept is being explored most extensively by CEOS, the Committee on Earth Observation Satellites. The CEOS Analysis Ready Data Strategy, released October 2019, provides the best introduction to the concept, and will eventually yield a definition. Of interest of the Strategy to this initiative is section 2.3: “Providing data in a form that is tailored to users is key to promoting uptake”. Efforts such as Digital Earth Africa and the emerging Digital Earth America vision that leverage data cubes also have many potential applications for disaster resilience. This initiative will also focus on the use of data cubes, related OGC standards, and advancing the use of ARD – to deliver the proper ARD to the right individual at the right time.

To be fully prepared for intermittent network availability, the pilot will develop best practices for data provisioning using GeoPackage offline containers. The work on GeoPackage will include two sides: First, the visualization of the right information at the right time using GeoPackage data containers and GeoPackage viewers, and second the generation of GeoPackage offline containers to allow taking all relevant information into the field.

All the aforementioned technologies will be explored based on the applications to the data software architecture, which allows the deployment and execution of containerized applications and simulation models on external cloud data and processing platforms.

This initiative will address disasters at various scales, from urban/city to national, from region to global, and will bring together experts from across the public and private sector. The list of stakeholders is illustrated to the left and includes professionals involved in recent disaster events. These professionals will help to identify clear communication pathways for fusing disparate geospatial data to provide the right information to the right person at the right time, improving readiness and response for future events. Results will be documented in guides to help the emergency / disaster management community adopt improved practices and to receive risk specific products.

SOCIAL HEALTH ECONOMIC RISK INFRASTRUCTURE PROPERTY

The goal of this proposal is to evaluate a minimum of two recent disaster events by working specifically with pre-defined End Users on collecting appropriate and timely information based on geospatial information that had been stymied during the disaster preparation or response phases in the past. The emphasis will be on the generation, sharing, and use of location information and associated IT tools for disaster preparedness and response, and design and test common interoperability best practices that can be adopted by organizations and jurisdictions to enable improved agility to prepare for, respond to, and manage progress of recovery from disaster events. The specific technologies to be included in the analysis are Machine Learning/Artificial Intelligence, Analysis Ready Data, and GeoPackage, as described above. Overall, the OGC Disaster Pilot Initiative will:

- Establish operational prototypes to support improved information sharing and application during the preparation and response phases of the disasters;
- Test and validate metadata applicable to establish disaster preparation and response indicators that can be used across cooperating organizations to assess preparation and response progress;
- Assess and validate the ARD delivered to the End User versus the "normal firehose" of data: ensure the information being delivered is the "the right information to the right person at the right time";
- Document results and recommendations in guides and develop training programs to assist adoption of best practices by organizations and professionals involved in emergency / disaster management; and
- Run two types of disasters operational scenarios: one based on wildfires, the other based on flooding;
- Include social, economic, environmental, analysis ready, and real-time data from various sources such as public information, academia, commercial, private, citizen science, and insurances. These include but are not limited to provider identified datasets and tools from sponsors and use case participants (e.g. Landsat, Nasa Disasters Program, Census data, NOAA GeoPlatform, USGS National Map, FGDC National Geospatial Data Assets, statistical data, GeoPlatform.gov etc.).

The pilot will be executed by inviting a set of world-class experts from different organizations. All participants will demonstrate an end-to-end solution that answers specific decision maker questions for the identified thematic area(s).

6. About the Open Geospatial Consortium

The Open Geospatial Consortium (OGC) is an international consortium of more than 500 companies, government agencies, research organizations, and universities driven to make geospatial (location) information and services FAIR - Findable, Accessible, Interoperable, and Reusable. OGC's member-driven consensus process creates royalty free, publicly available geospatial standards. Existing at the cutting edge, OGC actively analyzes and anticipates emerging tech trends, and runs an agile, collaborative Research and Development (R&D) lab that builds and tests innovative prototype solutions to members' use cases. OGC members together form a global forum of experts and communities that use location to connect people with technology and improve decision-making at all levels. OGC is committed to creating a sustainable future for us, our children, and future generations. Recommendations from these initiatives become new or revised open standards and best practices which help to improve decision making, reduce the time and cost in mobilizing new capabilities, and to save lives and minimize the impact to property and the environment.

OGC Members represent domains such as meteorology and oceans, emergency management, response and recovery; defense and intelligence; urban planning and management that are active in OGC. These organizations benefit from coordinating with others in their market or domain of interest. More importantly, members benefit greatly from their ability to advance solutions to address the complex challenge of cross-domain information sharing and processing to address increasingly complex issues such as climate change, and alternative energy planning.

In addition to its proven consensus process for advancing and adopting open standards for implementation and use worldwide, OGC emphasizes an Innovation Program of fast paced Concept Development Initiatives, Testbeds, Operational Exercise initiatives and Interoperability Experiments. These initiatives allow OGC members to rapidly conceptualize and develop candidate standards and best practice interoperability recommendations in an environment where these standards can be actively and rapidly developed, tested, validated and demonstrated in the context of real-world business scenarios.

Since its inception, OGC has been a major enabler of Spatial Data Infrastructure (SDI) programs worldwide to advance a common set of standards to enable the publishing, discovery, access, fusion and application of geospatial / location information for improved decision making. Supporting the rapid sharing, exchange, mobilization and application of varied geospatial information sources among organizations and jurisdictions via common standards and associated SDI practices is an underpinning role of open standards and the Open Geospatial Consortium. Open standards make possible agile sharing and exchange of location information, including parcel information, surface water, transportation networks, sensor observations, and citizen observations via mobile devices and social media feeds. OGC standards also facilitate the rapid and efficient extension of IT solutions to ingest and process new data especially from new technology sources.

The OGC does not work in isolation. OGC has a solid track record of partnering with the broader standards community with organizations such as ISO Technical Committee 211 (Geographic Information / Geomatics), OASIS, and the World Wide Web Consortium (W3C) to support cooperative standards and best practice development. OGC's alliance with the IJIS Institute (www.ijis.org) provides the Consortium with direct access to law enforcement and public safety community representation. Collaboration and partnerships with this organization and other private sector partners (such as airlines, major food and merchandise distributors), are key to addressing today's complex challenges.

The pilot will be executed according to the OGC Innovation Program policies and procedures (https://www.ogc.org/ogc/policies/ippp). These foresee that the OGC is fully responsible for the organization and execution of the initiative. The OGC Innovation Program team (IP Team) with input from all sponsors will develop a *Call for Participation* to solicit interest from software providers, services developers, and end-users to participate in the initiative. The IP Team with support from the OGC Marketing and Promotion team will ensure a wide distribution of the Call for Participation. The IP Team together with the sponsor(s) will select the best organizations to participate in the pilot and to receive cost-share funding.

7. Deliverables

All results, lessons learned, initiative descriptions, and best practices will be documented in the form of OGC Engineering Reports. The final reports will be publicly available once released by the OGC Committees. Software products and online services will remain with the initiative participants.

8. Schedule

The following tentative schedule identifies the major milestones of the Pilot.

1 October 2020	Contract Start
1 – 31 October 2020	Coordinate End Users with Sponsors
1 – 31 October 2020	Create Call for Participation (CFP)
1 November 2020	Release CFP
20 December 2020	CFP Closed
9 – 10 February 2020	Project Kickoff
13 April 2021	Workshop #1
20 May 2021	Workshop #2
16 July 2021	Draft ERs and Videos Due
31 July 2021	Final ERs and Videos Due
9 September 2021	Final Demo

9. Cost

The rough order of magnitude for sponsorship is USD 600,000 shared across multiple supporting sponsors. The OGC Innovation Program process accounts for varying sponsor requirements, varying levels of available funding, and is flexible enough to account for different procurement processes and timelines. The process is also open to the contribution of high value data to the initiative. Sponsorship funds are used to provide offset funding to participants, who are expected to contribute relevant in-kind resources.

Thanks in advance to all interested sponsors for

- Showing leadership by contributing to this critical and collaborative initiative
- Accelerating the development of a disaster response, recovery, mitigation, and preparedness IT services
- Ensuring the latest technologies and knowledge are utilized and mobilized for this cause
- Sharing the expertise, development and lessons learned

- Choosing to engage with an international diverse community of world-class experts to develop state of the art disaster services and concepts

Learn more about sponsoring an OGC Innovation initiative at ogc.org/ogc/innovation.

10. Contact

Interested in joining this pilot as a sponsor? Several sponsoring options are available, please contact program director Dr. Ingo Simonis via the OGC Innovation Program contact form at https://www.ogc.org/ogc/programs/ip#contact for more information.