RESILIENCEDIRECT MAPS - A COMMON OPERATING PICTURE FOR THE UNITED KINGDOM

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Abstract:

ResilienceDirect launched in the United Kingdom in June 2014 and revolutionized the way public agencies share information during emergency planning and response activities. This secure, cloud-based platform is provided by UK Cabinet Office and is free to all Category 1 and 2 emergency responders. This includes police forces, fire and ambulance services, NHS trusts, Local Resilience Forums, Public Health England, the Environment Agency, utility companies and many others. ResilienceDirect enables true multi-agency collaboration via a suite of secure cloud-based tools for sharing information and providing a common operating picture. A key component of the ResilienceDirect Service is the web-based mapping platform developed by Ordnance Survey, Great Britain’s National Mapping Agency. Designed as a map-based visualization tool for the aggregation, presentation and dissemination of multiple information sources, ResilienceDirect Maps provides a set of simple, user-friendly drawing tools and the ability to collaborate and edit maps in real time with other users. Built using open-source software and designed to support easy integration of OGC compliant web mapping services, ResilienceDirect is an exemplar for bringing together geospatial data from a wide range of commercial, open and government sources to more effectively plan and direct emergency response activities.

Key Words:
Agile; Cloud; Geospatial; Open-source; Resilience
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Ben Rodgers

Achieving true interoperability

In the United Kingdom, the structure for managing a multi-agency response to emergencies is based upon the Civil Contingencies Act (2004), which imposes a legal duty on Category 1 responders to assess risk, plan for emergencies and co-operate and share information with other emergency response organizations. The Joint Doctrine framework goes a step further and emphasizes the need for greater interoperability of the emergency services and wider responders during a response situation. Interoperability is defined as the extent to which organizations can work together coherently as a matter of routine. In the UK, a successful implementation of the Joint Doctrine framework has been achieved through extensive multi-agency training, the adoption of common terminology and ways of working, where joint working practices are embedded within standard operating procedures.

In support of these common ways of working and the demand for rapid access to information from a range of sources, a common operating platform, “ResilienceDirect”, has been developed by Cabinet Office Civil Contingencies Secretariat (CCS). Prior to the launch of ResilienceDirect, organizations found it difficult to share information efficiently and effectively during times of crisis. The siloed nature of some government departments and local agencies meant that systems, processes, and data formats often differed between organizations resulting in valuable time being wasted converting, interpreting, and disseminating information instead of acting upon the information. Incidents are rarely contained within one administrative region and thus the need arose for a common operating picture and a shared situational awareness that traversed administrative boundaries and crossed national borders. ResilienceDirect provided the answer in the form of a secure, cloud-based platform for all UK response agencies to collaborate, share and manage information to enable effective joint decision making.
Figure 1 highlights the high-level workflow within ResilienceDirect from information capture through to decision making.

ResilienceDirect is an accredited and secure cloud-based platform and suite of applications for civil contingency practitioners across the UK to:

- share emergency plans among Local Resilience Forum (LRF) members and others such as national/sub-national partner organizations and neighboring LRFs;
- maintain awareness of forthcoming exercises, events and meetings, and access related documentation such as agendas and minutes;
- compile and share situation reports and briefings between local responders, to enable integrated management of events and consistent provision of information to the public;
- communicate situation reports to lead government departments and facilitate national coordination/action in response to an incident if necessary;
• gather and review comments on new policies or plans before publication, and collate lessons learned following events;
• manage contact information to ensure a single, up-to-date version of distribution lists;
• issue news and guidance from central government to local responders via the Resilience Gateway;
• create, edit and share maps online, pulling in a range of datasets from remotely sensed imagery and web feeds through to user-generated geospatial layers, geotagged images and videos;
• reflect on and review past events via a detailed audit history of why decisions were made at specific points in time.

The cloud-based nature of ResilienceDirect has fundamentally changed the way that agencies work together and collaborate. Command and control centers across the United Kingdom can now make rapid and informed decisions based on a single view of the truth and can cascade and disseminate the information in real time to all response agencies involved, no matter where they are located. The cloud service is also fully scalable, supporting rapid growth in user adoption to over 17,500 users across 2,300 agencies.

Maps for shared situational awareness

A key component of the ResilienceDirect service is the secure web-based mapping platform developed by Ordnance Survey, Britain’s National Mapping Agency. Known as ResilienceDirect Maps, this map-based visualization and collaboration tool enables the aggregation, presentation and communication of multiple information sources and provides a suite of simple drawing tools designed specifically for the resilience user community.

ResilienceDirect Maps allows users to:

• rapidly create emergency planning and response maps using predefined templates and over 2,000 existing data layers;
• use simple drawing tools to quickly define boundaries and evacuation zones;
• dynamically query the map to retrieve a list of properties within user defined areas (see Figure 2);
• add markers and control points and apply relevant symbols to them;
• sketch, highlight and annotate features within an editable ‘Drawing Layer’ on top of the map;
• upload and link photos and videos for others to see within the map;
• import and overlay various spatial data file formats;
• easily connect to OGC compliant web services and view within the map;
• export the map to PDF and plot up to A0 size;
• dynamically compose, share and edit maps with other users in real time;
• send a link via email so that other people can view an interactive version of the map.

In exercises and emergency response activities, ResilienceDirect Maps consistently forms the central component of the ‘common operating picture’. Users now have a far better way of describing the geographical context of an incident compared with previous alternatives such as spreadsheets and other textual and verbal forms of communication. For the first time, decision makers and emergency responders across the UK have a consistent set of tools that enables them to compose and visualize the scene of an incident, track assets and response activities and take appropriate action in a collaborative and dynamic way. Furthermore, the addition of a common ‘language’ in the form of a nationally agreed civil
contingencies map symbology set (as illustrated in Figure 3) removes any ambiguities that may exist between one agency interpreting a feature on the map that might mean something else to another agency.

Figure 3: ResilienceDirect Maps displaying example symbols from the civil contingencies common symbology set. Source: Ordnance Survey.

User engagement to ensure success

Development of ResilienceDirect Maps began in late 2013, preceded by a series of user-led workshops to capture the broad set of functional and non-functional requirements needed to make the system useful for the target community. A user-centered approach from the outset ensured immediate buy-in. Users were encouraged to define and prioritize the features, content and functionality that mattered most to them. As a collective team, they also discussed and prioritized the backlog, resulting in a set of user stories that formed the basis of the first sprint. A dedicated Agile development team was established at Ordnance Survey to work through the backlog in three-week sprints. Regular review meetings were held with the user community to share progress and present the application at the end of each sprint. In little over three months, a minimum viable product (version of the application with the key features required to make it usable) was produced and released to a subset of the user community.
Since that first release in March 2014, the Agile development team has continued to enhance and refine the mapping application to extend its appeal and usage across a wider audience. Key stakeholders from across the user community have been active participants in the evolution of the product and quarterly national user group meetings provide an opportunity to gather feedback which is incorporated into the product backlog. Informal methods of capturing user feedback such as attendance at Local Resilience Forum meetings and emergency simulations and exercises also provide opportunities to capture new ideas and suggestions for future enhancements. This user-centered approach has been one of the key factors in the successful adoption of the ResilienceDirect maps system.

**Role of open-source and open standards**

To ensure widespread buy-in to ResilienceDirect, Cabinet Office was keen to remove all barriers to adoption. One such barrier was the previous commercial model where Category 1 and 2 responders paid on a subscription basis to access the service that ResilienceDirect eventually replaced. With pressure being exerted on UK agencies to make significant cost savings, the number of departments that could afford to pay for ResilienceDirect’s predecessor was dramatically declining. A centralized funding model was instead implemented which ensured the successful adoption of ResilienceDirect without the financial burden being placed on the response agencies. This free-at-point-of-use model has almost certainly played a key role in the success of ResilienceDirect.

In late 2013, open-source geospatial technologies were reaching a mature state and in the evaluation of technical options, an open-source development approach was selected above Commercial-off-the-Shelf (COTS) options. The combination of Agile development and open-source code also resonated strongly with the UK Government Digital Services team (GDS) who were championing this approach across UK Government at that time. Cabinet Office was also attracted to the open-source option as this gave them the rare opportunity to design and build a solution for the users entirely from the ground up. It also gave them greater flexibility in terms of scaling and deploying the solution to an ever-growing user community without being constrained to commercial licensing models. Figure 4 shows the open-source technologies Ordnance Survey used in the development of ResilienceDirect Maps.
Figure 4: The ResilienceDirect Maps technology stack.
Source: Ordnance Survey.
Making the cloud-based platform secure enough

A major concern raised by stakeholders at the beginning of the project was whether a cloud-based service could be secured sufficiently to protect the sensitive information being created and shared within the system. The challenge was set to find the right balance between information security protection and ease of access for the users. Discussions between the user community and the National Cyber Security Centre (formally CESG) centered on agreeing a suitable classification level and the accreditation required for the cloud hosting environment. Agreement was eventually reached on a combined classification and authentication mechanism that meant that the service could be accessed on any internet-connected device with the right credentials. Unlike the system ResilienceDirect was replacing, there was no longer a requirement for users to log in from a Government networked device or remotely using a SecurID token. This represented a major break-through in UK Government as it immediately opened up the platform to a much wider audience of permitted ‘resilience users’ both within and outside of Government. For the first time, Category 2 responders such as transportation and utility companies, the armed forces, Mountain Rescue and other voluntary agencies could access the same tools as their Category 1 counterparts.

Web mapping services for rapid and effective decision making

Recognizing that a visualization platform is only as good as the data within it, considerable effort has been devoted to working with government agencies to identify relevant datasets and to manipulate and prepare data for sustainable consumption within the platform. This approach represented a cultural and political challenge for some agencies where datasets were not freely available and no precedent had been set to ‘release’ their data for this type of capability. With the backing of Cabinet Office to make key datasets available under the Civil Contingencies Act, combined with the technical know-how of Ordnance Survey, a wide variety of datasets from across Government and the energy and utilities sector have been added to the system. Agencies were encouraged to provide OGC compliant web services for integration into ResilienceDirect Maps, rather than static files and to establish processes for keeping the data up-to-date and maintaining the quality. In order to encourage users and agencies to link and/or upload their datasets into the platform, simple asset management tools were developed to make that process as simple as possible. Using these tools, users can upload their own geospatial files and geotagged photos or videos, or add OGC compliant web map services in an intuitive way. This ‘Asset library’ (as depicted in Figure 5) also provides a means for users to search for relevant content added either by themselves or by other users who have chosen to tag and share their data. Users have the option of choosing whether they wish to
keep their data files and web services private, to share them with colleagues in their organization or to make their content publicly available to all registered users. This same sharing model also applies to the maps that users create.

Underpinning the ResilienceDirect Maps service is the definitive base mapping of Great Britain as provided by Ordnance Survey. Detailed Ordnance Survey mapping layers and property-level addressing information is provided free at point of use to all users under the terms of the Public Sector Mapping Agreement between Ordnance Survey and UK Government. This 10-year agreement, signed in April 2011, enables all public sector organizations to freely use Ordnance Survey mapping. As a result, Ordnance Survey mapping data and property-level information is made available free of charge to the resilience community via ResilienceDirect.

![ResilienceDirect Maps asset library](image)

*Figure 5: The ResilienceDirect Maps asset library allows users to upload geospatial layers as well as add and manage their Web Mapping Service (WMS) endpoints.*

*Source: Ordnance Survey.*

To provide the best possible performance and visual experience, Ordnance Survey datasets have been combined into a series of consistently styled zoom stacks and then integrated into the ResilienceDirect
Maps application as Web Map Tile Services (WMTS). WMTS is an interface that generates predefined map images from a cache. This provides a highly performant mechanism for users to pan and zoom within the map whilst accessing mapping content being served over the internet. 25cm resolution aerial imagery for Great Britain is also provided by Ordnance Survey as a Web Map Service (WMS) within ResilienceDirect Maps. The image processing software used by Ordnance Survey produces true-orthorectified imagery which removes building lean to provide a consistent top-down view that aligns seamlessly with all Ordnance Survey products. Additionally, the integration of the OS Places and OS Gazetteer APIs enables the ResilienceDirect Maps search tool to rapidly identify a place name, point of interest or individual property address and locate it on the map.

A key benefit of consuming mapping and addressing information as a web mapping service, is that there is no burden on the users or administrators of ResilienceDirect Maps to update the data themselves. The data update regime and management overhead is the responsibility of the data providers, meaning that users can always be assured of accessing the latest mapping information live and direct from the trusted source.

It is important to note, that the success of ResilienceDirect Maps can also be attributed to the commitment and effort made by many other data providers who have made their datasets available as APIs and web services for open consumption within the resilience community. Notable examples include British Geological Survey who provide Open Data datasets in an OGC compliant WMS format, as well as more detailed commercial WMS layers that can be enabled for viewing in emergency situations. Similarly, Environment Agency, Meteorological Office, Highways Agency, and many others ranging from regional and city councils to energy, infrastructure and commercial organizations have added their public (and in some cases, private) web services into ResilienceDirect Maps to support emergency decision making. This unique combination of live feeds from multiple sources, combined with ad-hoc content from users including ESRI shapefiles, CSV files, images and video content, makes for a rich library of information that can be rapidly accessed in a wide variety of planning and emergency situations. Figure 6 shows the extent of coverage for live river gauge data and flood warning information in Great Britain.
The ResilienceDirect ‘open’ access model has been hugely successful in driving not just the adoption of the tool, but also demand from the resilience community for government agencies to release more data in an open and accessible way to further support resilience decision making in times of crisis.

**ResilienceDirect Maps in action**

The winter of 2015 saw a series of storms bringing severe gales and record breaking rainfall across the northern UK, with record gusts of 96 mph in coastal areas and widespread flooding. The aftermath of the storm left devastation across the counties of Cumbria and Lancashire. Roads and bridges were damaged or destroyed, leaving local communities fractured and emergency responders facing long detours.

ResilienceDirect Maps was used to aggregate, present and convey real time flood and storm damage information to responders locally, regionally and to Government Ministers in London at an emergency
committee (COBR). Figure 7 illustrates how ResilienceDirect Maps was used to visualize the potential impacts of a major flood event in this region and to prepare and respond accordingly.

![Figure 7: Visualizing potential flood impacts by overlaying flood warning polygons over topographic base mapping within ResilienceDirect Maps. Source: Ordnance Survey.](image)

Using ResilienceDirect Maps, the Strategic Coordination Group was able to compile multiple information sources to monitor the flood warning areas and river levels to make informed decisions such as bringing in the necessary resources to implement flood defenses, rebuild and replace bridges and road infrastructure, and coordinating and instructing emergency rescue teams in the evacuation of vulnerable people.

In January 2017, three instances of H5N8 Avian influenza were reported in North West England and ResilienceDirect Maps was used to locate the occurrences and to manage the response activities. A 10km Surveillance Zone and an inner 3km Protection Zone was immediately created around each location using the sectorized circle tool within ResilienceDirect Maps. Residential and commercial properties within these zones could then be instantly identified using the address querying tool to retrieve property information directly from the Ordnance Survey Places API (as shown in Figure 8). This list of properties could then be exported to a Microsoft Excel file, as well as viewed dynamically within ResilienceDirect, to conduct house to house visits, for example to investigate the infection and identify other infected and susceptible birds.
Figure 8: ResilienceDirect Maps being used to create a 3km Protection Zone and to identify adjacent properties in response to an Avian flu case in North West England. Source: Ordnance Survey.

In Figure 8, note the column labelled ‘UPRN’. The UPRN is a unique alphanumeric identifier for every address in Great Britain. It provides the definitive link between the geographic location of a property and the attributes associated with a property, for example; is it a residential or commercial property; what type of business is conducted there; is it a detached, semi-detached or terrace property; what is the full address and postal code (zip code); what is the footprint size etc. The UPRN acts as a comprehensive and consistent identifier throughout a property’s life cycle, from planning permission to demolition. Used widely across Government, the UPRN enables agencies to be more consistent and effective in sharing property related information with the confidence that conferring agencies are referencing the same physical entity. In an emergency services example, the UPRN is relied upon to ensure that the police, fire or ambulance crew can instantly pinpoint the location of a property and travel to it in as short a time as possible.

In the Avian flu example, ResilienceDirect Maps proved very effective in the creation of response maps and the sharing of time critical information between the various response agencies which prevented the
infection spreading further. The detailed mapping data was particularly helpful in enabling the health agencies to quickly identify watercourses, drainage channels, outbuildings and other land use types that could increase the potential for the disease to spread.

Figure 9 illustrates the level of detail provided by the Ordnance Survey map stack for the whole of Great Britain which underpins all manner of emergency response activities.

![ResilienceDirect Maps](image)

**Figure 9: ResilienceDirect Maps demonstrating the detailed topographic mapping data available to all response agencies to better inform decision making – in this case with regards to Avian flu.**

*Source: Ordnance Survey.*

**Moving towards a Resilience Hub**

Building on the strength of the existing ResilienceDirect Maps application and the enthusiastic user adoption of the broader set of collaboration tools within ResilienceDirect, Cabinet Office and Ordnance Survey have developed a vision of a future Resilience Hub (as depicted in Figure 10).
The Resilience Hub will bring together a suite of new and refreshed tools in a seamless and fully integrated environment for users. Users will be able to log-in once to access all the services they need and will be able to geo-tag documents so that relevant documents can be identified and opened from within the mapping application. ResilienceDirect Maps will form a central part of the Hub, providing a common interface and link between applications to extend the reach of mapping into core business tools such as Document Management, Events Calendar, Chat tool and People Directory etc. A key objective for the Hub is to provide a platform that allows third party developers to develop innovative solutions for the Resilience community and for accredited solutions to be easily integrated via the use of open standards and APIs. This has already seen some success in the form of the National Casualty Bureau application which was funded by Thames Valley Police, but is now widely used by the broader ResilienceDirect community. The aim is to build applications once and then share them across the community via the Resilience Hub so that everyone can benefit.

Looking ahead, a number of new resilience tools are also planned or under development. One example is the Flooded Property Tool which was commissioned by the Department for Environment, Food and Rural
Affairs (DEFRA). In January 2017, a beta version of the Flooded Property Tool was released to users after just 9 weeks’ development by the Ordnance Survey team. The tool enables response agencies to rapidly identify and accurately report properties that have been affected by flooding and to record the extent of the impact via a simple web app that combines mapping and address-level information. The requirement for this tool was first highlighted in the National Flood Resilience Review (NFRR) which noted a capability gap with regards accurate and consistent reporting on properties affected by flooding between local and central Government departments. The absence of this single and consistent view was both hampering response and recovery activities and delaying the release of funding from Government to support these efforts. The Flooded Property Tool now provides a simple means to centrally record the impacts of flooding events and to make the case for Government funding according to the number of properties affected. When the Beta trial concludes in April 2017, it is anticipated that the Flooded Property Tool will be refined and deployed as a live service in the summer of 2017.

In conclusion, ResilienceDirect has revolutionized the way that agencies across the United Kingdom engage and collaborate with one another in times of crisis. Demand for new features, new content and new applications is being met through the continued sponsorship of UK Cabinet Office, and the creation of the new Resilience Hub will enable other agencies to sponsor and deploy additional accredited applications that will benefit the wider community.

ResilienceDirect Maps plays a key role in providing the common operating picture and in enabling a shared situational awareness across UK agencies. The user-centered design approach ensures continued user buy-in and commitment to the mapping platform and has been a catalyst for unlocking access to geospatial content previously trapped in Government silos. ResilienceDirect Maps continues to attract the attention of Ministers and senior stakeholders across UK Government and overseas. In 2017, the first steps towards developing the ResilienceDirect Hub, with its fully-integrated and seamless user experience, opens up a new and exciting chapter for the United Kingdom resilience community!
What our stakeholders say…

‘ResilienceDirect has transformed the way that local resilience forums share work and good practice, dramatically improving information-flow which is so critical in a major incident.’

Paul Netherton, ACC Devon and Cornwall Police

‘ResilienceDirect mapping is an essential tool for ministers and is testament to Civil Contingencies Secretariat’s collaboration with partners.’

Rt Hon Sir Oliver Letwin MP

‘ResilienceDirect will allow Thames Water to communicate and plan alongside the wider resilience group. Due to the geography and sheer size of our operations it’s a perfect way to share information, planning & procedures and should encourage asset data sharing which will prove invaluable in circumstances such as the widespread flooding of 2013–14.’

Chris Fitzgerald, Business Resilience and Security Manager, Thames Water
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