Review of the 'Sendai Framework for Disaster Risk Reduction 2015-2013'

for Scoping Disaster Risk Reduction for Earth Observation

Project Title: Disaster Risk Resilience Scoping Project

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List of Abbreviations

DAC	Development Assistance Committee
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EO	Earth Observation
ESA	European Space Agency
GEO	Group on Earth Observations
NCEO	National Centre for Earth Observation
RS	Remote Sensing

1. Introduction

The use of Earth Observation (EO) for disaster risk reduction (DRR) is emphasised by the UN's 'Sendai Framework for Disaster Risk Reduction 2015-2030', which was adopted by 187 UN member states in March 2015 at the UN World Conference on Disaster Risk Reduction in Sendai, Japan. This document provides a review of this global framework for scoping how EO can be used for DRR. The purpose of undertaking this review is for the *Disaster Risk Resilience Scoping Project*, which has the long-term objective of 'improved disaster risk reduction (DRR) for Development Assistance Committee (DAC) countries by integrating space based Earth Observation data, particularly focusing on the Horn of Africa'. The project's short-term objective is to exploit the international convening power of GEO (Group on Earth Observations), the National Centre for Earth Observation's (NCEO) role as UK GEO coordinators (funded by NERC National and Public Good) and NCEO's scientific expertise in using EO in the field of natural disasters. Focusing on countries in Africa, specifically Kenya and Uganda, is very important. The Sendai Framework highlights that African countries need special attention and support because they are continuously facing disaster-related challenges and an increase of risks (UN, 2015a).

In 2012, the UN's Global Pulse White Paper on Big Data for Development noted the potential of EO in academia and decision making (Global Pulse, 2012). The UN's Framework Convention on Climate Change also emphasised the contribution of earth observation on 34 Essential Climate Variables (UNFCCC, 2006). Furthermore, in 2015 the Sendai Framework, which is the successor to the 'Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters', emphasised the usage of remotely-sensed EO for DRR (UN, 2015a).

Using EO for DRR has the potential to improve Disaster Risk Management (DRM). According to the UN (2015b), using EO and space-based information systems is vital to address the four priorities emphasised with the Sendai Framework. This document will further explore how EO can be used for DRR and how EO can be incorporated into the Sendai Framework. Incorporating EO into this Framework can have a lot of impact because it comprises of seven global targets for the next 15 years and it has been adopted by 187 UN Member States (UN, 2015a). These States have made a 'commitment to address disaster risk reduction and the building of resilience[2] to disasters with a renewed sense of urgency within the context of sustainable development and poverty eradication, and to integrate, as appropriate, both disaster risk reduction and the building of resilience into policies, plans, programmes and budgets at all levels' (UN, 2015a: 9). This indicates that if EO can assist with addressing DRR and the building of resilience to disasters, then the UN Member States would be open to using EO. Therefore, one of the aims of this document is to show how EO can assist with addressing DRR and the building of resilience to disasters.

In order to achieve the aims of this document, terminology will initially be defined in order to provide some clarity. Subsequently, this document will explore how EO has previously supported DRR through other projects. Subsequently, our own EO-Sendai Framework nexus will be developed by conducting a review of the Sendai Framework in a structured manner.

This section will be followed by a brief analysis of the review's main findings. This analysis will be done by exploring EO under the three phases of DRM. Conclusively, specific findings in relation to this project will briefly be identified.

2. Terminology

Prior to reviewing the Sendai Framework, it is important that a few terms are clearly defined. Therefore, this section will briefly cover the following main terms: disaster risk reduction, disaster risk management, remote sensing and Earth Observation.

2.1 Disaster Risk Reduction

According to UNISDR (2017), DRR is a broad 'concept and practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction". Furthermore, DRR 'is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development.' (UNISDR, 2009). According to the Sendai Framework, focusing on DRR is very beneficial because it is 'a cost-effective investment in preventing future losses' (UN, 2015a: 9). DRR consists of three disciplines: disaster management, disaster response and disaster preparedness (UNISDR, 2017). These are operational elements of DRR, collectively known as disaster risk management (DRM).

2.2 Disaster Risk Management

DRM "is the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses" (UNISDR, 2009). According to UNISDR (2017), DRM encompasses three operational elements: disaster management, disaster response and disaster preparedness. These operational elements fall under the UN's recommended disaster management cycle, which includes three main phases: "the pre-emergency phase, the emergency phase and the post-emergency phase" (UN, 2002: 5). The management of a disaster involves each of its phases (See **Figure 1**) and should begin as early as possible, especially since it could affect the public's safety and well-being. However, disaster management can be challenging since a disaster is not always predictable because each situation is unique and requires different management strategies (The World Bank, 2010).

Figure 1: Disaster Risk Management Cycle

Source: Author, adapted from UN (2002)

According to Khan *et al.* (2008), the pre-emergency phase involves two main stages: mitigation and preparedness. These stages are included in the operational element of disaster management and disaster preparedness. Disaster preparedness relies on a good early-warning system. The emergency-phase tend to be short-term (UN, 2002) but is vital because it involves "the initial response [which] is normally provided by the statutory emergency services and, as necessary, by the appropriate local authorities and possibly voluntary organisations" (Home Office, 1998: 6). The post-emergency phase involves recovery and encompasses the changeover from the recovery and relief stage to the rehabilitation, reflection and learning stage (UN, 2002). The recovery stage is normally a long-term process that involves improving both the affected area and the area's future resilience to disasters. The entire set of phases of the disaster management cycle include: 'prevention, mitigation, preparedness, response, rehabilitation, reconstruction and recovery' (UN-SPIDER, 2014).

Disaster management plans should include all of the phases of the disaster management cycle. "Disaster risk management plans set out the goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives. They should be guided by the Sendai Framework for Disaster Risk Reduction 2015-2030 and considered and coordinated within relevant development plans, resource allocations and programme activities." (UNISDR, 2009). It is recommended that every nation has a national disaster management plan or some form of master plan (Moe and Pathranarakul, 2006). A national disaster management plan is a detailed plan of action on how to manage overall disasters from a national perspective, while contingency plans, strategic plans and emergency preparedness plans are more specific. The government generally is the only one to create a national disaster management plan since it is their main responsibility to guarantee the protection and preparedness of its population at all times, including during the occurrence of a disaster (IFRC, 2000).

2.3 Remote Sensing and Earth Observation

Campbell and Wynne (2011:4) consider remote sensing (RS), in broad terms, to be: 'the gathering of information at a distance'. Another broad definition for RS is: 'the observation of a target by a device separated from it by some distance" (Barrett and Curtis, 1976: 3).

According to the National Academy of Sciences (1970: 1), RS is 'the term currently used by a number of scientists for the study of remote objects (earth, lunar, and planetary surfaces and atmospheres, stellar and galactic phenomena, etc.) from great distances. More specifically, RS can also be defined as: 'the practice of deriving information about the Earth's land and water surfaces using images acquired from an overhead perspective, using electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the Earth's surface" (Campbell and Wynne, 2011: 6). Thus, EO involves using RS techniques to study, observe and gather information specifically on Earth, instead of the other remote objects. According to CEOS (2012), "Satellite data, particularly Earth observation data, can provide valuable, unique information supporting both research into natural hazards and their causes and operational decision-making tied to both planning and response".

Earth observation (EO) is the study and observation of Earth by gathering information specifically on Earth's physical, chemical and biological systems with the use of remote sensing technologies, such as satellite imagery (GEO, 2017). It involves monitoring the Earth's natural and manmade environment and collecting data in order to analyse and assess the current situation, any changes and historical trends.

3. How EO has Previously Supported Disaster Risk Reduction

EO has previously supported DRR within different projects, mainly focusing on the response phase of disasters (UN, 2015b). However, EO is not being used to its full capacity. This may be due to 'the perception of the high cost of satellite imagery and the reluctance to use low-resolution imagery' (UN, 2015b: 8). This perception is not always accurate as several satellite operators (e.g. the European Space Agency) are making their data openly available and free of charge. Some projects that have used or are currently using EO/RS are mentioned below to show the potential of using EO/RS for disaster risk reduction.

3.1 Mapping Flood Risk with Future Flow and Precipitation

The Geography Department at Loughborough University, as lead research organisation, and the University of Reading, as project partner, conducted a project on 'Mapping Flood Risks with Future Flow and Precipitation' from January 2016 to June 2016. The project's Principal Investigator was Dr Dapeng Yu and it was funded by NERC. The project aimed to "develop a prototype mapping service for future flood risks at a test site, focusing on flooding from both the river and intense rainfall" (GTR, 2017a) and to "evaluate the usability of remotely sensed data for flood risk management, in particular flood modelling" (GTR, 2017a). To do this, remote sensing data including, e.g. RADAR, aerial photos and satellite images was collected for previous events" (GTR, 2017a) and the data was "used to evaluate their capacity for providing input data for flood modelling and model evaluation" (GTR, 2017a).

3.2 Disaster Risk Evaluation and Management (DREAM)

In 2009, a project called 'Disaster Risk Evaluation and Management (DREAM)' was conducted by an international and interdisciplinary team of experts at a session of the International Space University in NASA Ames Research Center in California, USA. The aim of the project was "to explore the combination of current, planned and potential space-aided, airborne, and ground-based Earth observation tools, the emergence of powerful new web-based and mobile data management tools, and how this combination can support and improve

the emerging field of disaster risk management" (Dyke, *et al.,* 2010: 301). The project used Belize as a case study because it was a good test platform due to being small in size and population. Additionally, it was believed that the lessons learnt in Belize could be applied to both Central America and the Caribbean. One of the project's main finding was that it was critical to obtain high resolution EO data for disaster risk management. Another finding was that "space-aided, airborne, and ground-based technologies and recommendations have an immense potential" (Dyke, *et al.,* 2010: 315) to the World Bank's Comprehensive Approach to Probabilistic Risk Assessment (CAPRA) program, as well as other risk assessments. Furthermore, the project suggested "[m]ethods of outreach to both the space community and the general public" (Dyke, *et al.,* 2010: 314), which resulted "in the development of a prototype iPhones application for gathering CAPRA input data" (Dyke, *et al.,* 2010: 314).

3.3 Landslide Multi-Hazard Risk Assessment, Preparedness and Early Warning

A project on 'Landslide Multi-Hazard Risk Assessment, Preparedness and Early Warning in South Asia: Integrating Meteorology, Landscape and Society' is currently ongoing. This project is being funded by NERC and the funding period is from November 2016 to October 2020. The lead research organisation is the Engineering Geology Department of NERC British Geological Survey and the Principal Investigator is Dr Helen Reeves.

The project will build on existing scientific research and do "research to understand weather regimes (previously not done in South Asia) and rainfall characteristics that trigger landslides and geomorphological/geological control factors that can enhance landslide susceptibility" (GTR, 2017b), as well as "improving EWS effectiveness through integrating social dynamics information gathered from both 'Human' (i.e. social media) and physical sensors (remote sensing and pre-existing site-specific wireless networks deployed by AMRITA)" (GTR, 2017b). The project "will operate in partnership with decision makers, in public and private sectors, academics and non-for profit agencies to achieve an overarching aim of contributing to better landslide risk assessment and early warning, in a multi-hazard framework in India, aiming to increase resilience and reduce loss" (GTR, 2017b). Overall this project will result in improving landslide risk assessment and early warning with the use of remote sensing.

4. Review of the Sendai Framework

The purpose of reviewing and analysing the Sendai Framework is to identify scopes for incorporating EO within DRR. Additionally, this review will identify how geospatial and space-based technologies and related services can support national measures for DRR.

By incorporating EO in the Sendai Framework, the chance of the Framework's overall aim being achieved will increase. The Framework's aim is: "The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries." (UN, 2015: 12). Additionally, incorporating EO in the Sendai Framework will assist with addressing the 'seven global targets', (UN, 2015a: 12); predominantly the following targets:

> (d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030 [EO can be part of the following activities: hazard

mapping, risk assessment, and urban planning. These activities can assist with this specific target.];

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030 [EO, geospatial and space-based technologies can be used to improve international cooperation by sharing data and by having collaborative projects. Additionally, sustainable support to complement developing countries actions can be provided by sharing EO data and through training on RS and GIS.];

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030 [EO involves monitoring and gathering information about our Earth and our environment. Additionally, satellite imaging, radar and seismic probes can provide data that can be used to predict weather, overview natural resources and to respond to natural disasters. Thus, EO has the potential to improve multi-hazard early warning systems and disaster risk information.].

(UN, 2015a: 12).

The following table identifies exactly where there is potential for EO within the Sendai Framework (UN, 2015a). The text in the second column has been directly copied from the Framework and the text highlighted indicates the most relevant aspects.

Section	Context from the Sendai Framework	Potential for EO and This Project
Goal	Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.	- Technological measures, such as EO and GIS mapping of hazards, can be used to 'prevent and reduce hazard exposure and vulnerability to disaster'. - Technological measures, such as EO, can be used to 'increase preparedness for response and recovery'.
Guiding Principles		
(a)	Each State has the primary responsibility to prevent and reduce disaster risk, including through international, regional, subregional, transboundary and bilateral cooperation. The reduction of disaster risk is a common concern for all States and the extent to which developing countries are able to effectively enhance and implement national disaster risk reduction policies and measures in the context of their respective circumstances and capabilities can be further enhanced through the provision of sustainable international cooperation;	- Sharing EO data and enhancing cooperation between countries can be used to assist with this principle. - EO can be used as a tool to assist with preventing and reducing natural disaster risk. For instance, satellite images can be used by to identify weather trends and forecast the weather.
(c)	Managing the risk of disasters is aimed at protecting persons and their property, health,	- To protect people's livelihoods and environmental assets, it is

	livelihoods and productive assets, as well as cultural and environmental assets, while promoting and protecting all human rights, including the right to development;	first important to identify what they are. Through the use of EO, environmental assets and people's livelihoods (farming, fishing) can be located.
(e)	Disaster risk reduction and management depends on coordination mechanisms within and across sectors and with relevant stakeholders at all levels, and it requires the full engagement of all State institutions of an executive and legislative nature at national and local levels and a clear articulation of responsibilities across public and private stakeholders, including business and academia, to ensure mutual outreach, partnership, complementarity in roles and accountability and follow-up;	- The project has great potential to improve cooperation and collaboration across sectors and with relevant stakeholders at all levels. - The project involves partnership between businesses, academia and governmental organisations.
(f)	While the enabling, guiding and coordinating role of national and federal State Governments remain essential, it is necessary to empower local authorities and local communities to reduce disaster risk, including through resources, incentives and decision-making responsibilities, as appropriate;	- EO, as a resource, can empower local authorities. - EO can also assist with decision-making.
(g)	Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data, including by sex, age and disability, as well as on easily accessible, up-to-date, comprehensible, science-based, non-sensitive risk information, complemented by traditional knowledge;	- EO can assist with risk-informed decision-making. - EO is a science-based tool that can provide risk information.
(k)	In the post-disaster recovery, rehabilitation and reconstruction phase, it is critical to prevent the creation of and to reduce disaster risk by "Building Back Better" and increasing public education and awareness of disaster risk;	- EO can be used as a tool to monitor recovery in the built environment. - Satellite EO can be used to assess the damage of a disaster (e.g. an earthquake).
(l)	An effective and meaningful global partnership and the further strengthening of international cooperation, including the fulfilment of respective commitments of official development assistance by developed countries, are essential for effective disaster risk management;	- This project has the potential to develop meaningful global partnerships between UK organisations/institutions and the government, NGOs and other key stakeholders from Kenya, Rwanda and Uganda.
(m)	Developing countries, in particular the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income and other countries facing specific disaster risk challenges, need adequate, sustainable and timely provision of support, including through finance, technology transfer and capacity building from developed countries and partners tailored to their needs and priorities, as identified by them.	- This project, which focuses on three African countries (Kenya, Rwanda and Uganda) that faces specific disaster risk challenges, aims to improve disaster risk reduction through increased use of EO data. - This project involves identifying how developing countries can be supported using technology,

		specifically EO but it focuses on the countries' specific needs and priorities.
Priority 1: Understanding Disaster Risk		
Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be leveraged for the purpose of pre-disaster risk assessment, for prevention and mitigation and for the development and implementation of appropriate preparedness and effective response to disasters.		
To achieve this at national and local levels, it is important:		
24 (a)	To promote the collection, analysis, management and use of relevant data and practical information and ensure its dissemination, taking into account the needs of different categories of users, as appropriate;	- EO information and data can be collected, analysed, managed and used to improve the understanding of disaster risk, especially in regards to the environment. - Promoting the collection, analysis and use of EO data and information can be used for: risk assessments, exposure assessment, vulnerability assessment, hazard assessment, improving communities' preparedness to a disaster, hazard monitoring and responding to disasters more effectively. - EO data can be specifically collected, analysed, managed and used dependent on the user needs.
24 (b)	To encourage the use of and strengthening of baselines and periodically assess disaster risks, vulnerability, capacity, exposure, hazard characteristics and their possible sequential effects at the relevant social and spatial scale on ecosystems, in line with national circumstances;	- EO can be used to periodically assess disaster risks and exposure. - EO can assess hazard sequential effects based on historical EO data. - EO can assist with producing baseline maps.
24 (c)	To develop, periodically update and disseminate, as appropriate, location-based disaster risk information, including risk maps, to decision makers, the general public and communities at risk of exposure to disaster in an appropriate format by using, as applicable, geospatial information technology;	- RS and GIS are geospatial information technology. - EO can assist with developing location-based disaster risk information, such as risk maps (e.g. a map indicating the flood-prone areas). - EO satellite images are a good tool, as well as an appropriate format to disseminate disaster risk information. This tool is visual and therefore can make the risk information more comprehensive for decision

		makers, the general public and communities that are at risk.
24 (f)	To promote real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data;	- GIS can analyse and present spatial or geographic data, such as EO satellite images. - GIS can increase the understanding of disaster risk and contribute to disaster risk management. - This project is scoping the potential to promote access to reliable data and the use of space and situ information.
24 (h)	To promote and improve dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science- policy interface for effective decision-making in disaster risk management;	- This project promotes and will improve the dialogue among scientific and technological communities and other relevant stakeholders. - EO can assist with effective decision-making in disaster risk management.
24 (j)	To strengthen technical and scientific capacity to capitalize on and consolidate existing knowledge and to develop and apply methodologies and models to assess disaster risks, vulnerabilities and exposure to all hazards;	- EO can be used to assess disaster risks, vulnerabilities and exposure to different types hazards. - EO can strengthen technical and scientific capacity, as well as capitalize on existing knowledge.
24 (k)	To promote investments in innovation and technology development in long-term, multi-hazard and solution-driven research in disaster risk management to address gaps, obstacles, interdependencies and social, economic, educational and environmental challenges and disaster risks;	
To achieve this at global and regional levels, it is important:		
25 (a)	To enhance the development and dissemination of science-based methodologies and tools to record and share disaster losses and relevant disaggregated data and statistics, as well as to strengthen disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems;	- EO is a science-based methodology that has the ability to strengthen disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems.
25 (b)	To promote the conduct of comprehensive surveys on multi-hazard disaster risks and the development of regional disaster risk assessments and maps, including climate change scenarios;	- EO can help with the development of regional disaster risk assessments and maps, including climate change scenarios (Guo *et al.*, 2015).
25 (c)	To promote and enhance, through international cooperation, including technology transfer, access to and the sharing and use of non-sensitive data and information, as appropriate, communications and geospatial and space-based technologies and	- EO is geospatial and space-based technology that can be used to observe the earth, its environment and its climate.

	related services; maintain and strengthen in situ and remotely-sensed earth and climate observations; and strengthen the utilization of media, including social media, traditional media, big data and mobile phone networks, to support national measures for successful disaster risk communication, as appropriate and in accordance with national laws;	- This project contributes to international cooperation through its workshops. - This project is scoping where technology (EO data) can be transferred and shared.
25 (d)	To promote common efforts in partnership with the scientific and technological community, academia and the private sector to establish, disseminate and share good practices internationally;	- This project involves the cooperation of people in the scientific community, academia and the private sector at an international level.
25 (e)	To support the development of local, national, regional and global user-friendly systems and services for the exchange of information on good practices, cost-effective and easy-to-use disaster risk reduction technologies and lessons learned on policies, plans and measures for disaster risk reduction;	- EO can be an easy-to-use disaster risk reduction technology. - EO can assist with environmental monitoring, meteorology and making risk maps.
25 (g)	To enhance the scientific and technical work on disaster risk reduction and its mobilization through the coordination of existing networks and scientific research institutions at all levels and in all regions, with the support of the United Nations Office for Disaster Risk Reduction Scientific and Technical Advisory Group, in order to strengthen the evidence-base in support of the implementation of the present Framework; promote scientific research on disaster risk patterns, causes and effects; disseminate risk information with the best use of geospatial information technology; provide guidance on methodologies and standards for risk assessments, disaster risk modelling and the use of data; identify research and technology gaps and set recommendations for research priority areas in disaster risk reduction; promote and support the availability and application of science and technology to decision-making; contribute to the update of the publication entitled "2009 UNISDR Terminology on Disaster Risk Reduction"; use post-disaster reviews as opportunities to enhance learning and public policy; and disseminate studies;	- EO (geospatial information technology) can be used to disseminate risk information.
25 (i)	To enhance access to and support for innovation and technology, as well as in long-term, multi-hazard and solution-driven research and development in the field of disaster risk management.	- EO technology can be used to support long-term, multi-hazard and solution-driven research and development in the field of disaster risk management.
Priority 2: Strengthening Disaster Risk Governance to Manage Disaster Risk		
Disaster risk governance at the national, regional and global levels is of great importance for an effective and efficient management of disaster risk. Clear vision, plans, competence, guidance and coordination within and across sectors, as well as participation of relevant stakeholders, are needed. Strengthening disaster risk governance for prevention, mitigation, preparedness, response, recovery		

and rehabilitation is therefore necessary and fosters collaboration and partnership across mechanisms and institutions for the implementation of instruments relevant to disaster risk reduction and sustainable development.		
To achieve this at national and local levels, it is important:		
27 (a)	To mainstream and integrate disaster risk reduction within and across all sectors and review and promote the coherence and further development, as appropriate, of national and local frameworks of laws, regulations and public policies, which, by defining roles and responsibilities, guide the public and private sectors in: (i) addressing disaster risk in publically owned, managed or regulated services and infrastructures; (ii) promoting and providing incentives, as relevant, for actions by persons, households, communities and businesses; (iii) enhancing relevant mechanisms and initiatives for disaster risk transparency, which may include financial incentives, public awareness-raising and training initiatives, reporting requirements and legal and administrative measures; and (iv) putting in place coordination and organizational structures;	- A policy paper can be developed elaborating on how EO can be used for disaster risk reduction. - EO can be a mechanism and an initiative to enhance disaster risk transparency. - EO satellite images and subsequently, developed hazard maps can be used as highlighting disaster risks in national and local frameworks of laws, regulations and public policies.
27 (h)	To empower local authorities, as appropriate, through regulatory and financial means to work and coordinate with civil society, communities and indigenous peoples and migrants in disaster risk management at the local level;	- Sharing EO data with local authorities would improve their ability to work and coordinate with civil society, communities and indigenous peoples and migrants in disaster risk management at the local level. - Combining EO data with indigenous knowledge could potentially be used to reduce disaster risks, as well as improve the at-risk communities' resilience to disasters (by identifying coping/adaptation strategies). - Providing RS and GIS training to local authorities would empower them.
To achieve this at global and regional levels, it is important:		
28 (a)	To guide action at the regional level through agreed regional and subregional strategies and mechanisms for cooperation for disaster risk reduction, as appropriate, in the light of the present Framework, in order to foster more efficient planning, create common information systems and exchange good practices and programmes for cooperation and capacity development, in particular to address common and transboundary disaster risks;	- EO can be used to assist with planning disaster risk reduction strategies. For instance, EO can prioritise the most hazard-prone areas that may be transboundary or hazard-prone areas affected by a different area (e.g. a damn may be in one country which affects the water flow of a river in its neighbouring country). - A shared GIS platform can be developed to enhance the cooperation for disaster risk reduction.

28 (d)	To promote transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources, such as within river basins and along coastlines, to build resilience and reduce disaster risk, including epidemic and displacement risk;	- EO data can be shared to promote transboundary cooperation. - EO can identify/map the location of the shared resources and identify how to get the resources to the people. - EO can be used to indicate where epidemic and displacement risk may be in order to reduce it. - EO can be used to improve transboundary planning because EO can extensively map a localised area (potentially one that is difficult to access), identify vulnerable areas and be representative of the current situation.
Priority 3: Investing in Disaster Risk Reduction for Resilience		
Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation.		
To achieve this at national and local levels, it is important:		
30 (a)	To allocate the necessary resources, including finance and logistics, as appropriate, at all levels of administration for the development and the implementation of disaster risk reduction strategies, policies, plans, laws and regulations in all relevant sectors;	- EO technology and GIS software can be considered as a necessary resource for the implementation of disaster risk strategies; however, of course this is not on the top-list of necessary resources.
30 (c)	To strengthen, as appropriate, disaster-resilient public and private investments, particularly through structural, non-structural and functional disaster risk prevention and reduction measures in critical facilities, in particular schools and hospitals and physical infrastructures; building better from the start to withstand hazards through proper design and construction, including the use of the principles of universal design and the standardization of building materials; retrofitting and rebuilding; nurturing a culture of maintenance; and taking into account economic, social, structural, technological and environmental impact assessments;	- EO can be used as a tool to undertake an environmental impact assessment. - EO can be used to identify 'safe' locations where infrastructure should be built. - EO can assist with sustainable urban planning by providing up-to-date spatial information about urban areas (Musakwa and Van Niekerk, 2014). - EO can be used to identify flood-prone areas and distinguish where land is elevated. - EO can also map agricultural land. - RS can be used to identify land contamination.
30 (d)	To protect or support the protection of cultural and collecting institutions and other sites of historical, cultural heritage and religious interest;	- RS can be used to monitor sites of historical, cultural and religious interest. For instance, since 2003, UNESCO has been using RS techniques and EO to

		monitor some of the World Heritage Sites (Negula *et al.*, 2015).
30 (f)	To promote the mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning, land degradation assessments and informal and non-permanent housing, and the use of guidelines and follow-up tools informed by anticipated demographic and environmental changes	- EO can be used to conduct disaster risk assessments. - EO can be used to mainstream disaster risk into urban planning and land degradation assessments.
30 (g)	To promote the mainstreaming of disaster risk assessment, mapping and management into rural development planning and management of, inter alia, mountains, rivers, coastal flood plain areas, drylands, wetlands and all other areas prone to droughts and flooding, including through the identification of areas that are safe for human settlement, and at the same time preserving ecosystem functions that help to reduce risks;	- EO can be used to conduct disaster risk assessment, mapping and management. - EO is a very applicable tool to use to mainstream disaster risk and disaster management into rural development planning and management of the environment (e.g. mountains, rivers, etc.). - EO can assist with identifying areas that are safe for human settlement.
30 (k)	People with life-threatening and chronic disease, due to their particular needs, should be included in the design of policies and plans to manage their risks before, during and after disasters, including having access to life-saving services;	- Up-to-date and detailed EO images can be created to identify where people with life-threatening and chronic disease are, as well as where the most capable health facility is located. Additionally, these images can also show the relationship between these people and the vulnerable/hazard-prone areas. Subsequently, these mapped out images can assist disaster responders to locate these people when a disaster strikes and assist the responders determine the safest travel route, especially if a certain area is not accessible (e.g. if it is flooded).
30 (n)	To strengthen the sustainable use and management of ecosystems and implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction;	- EO can assist with managing and monitoring ecosystems. - EO can map the environmental and natural resources, which can strengthen the management approaches that incorporate disaster risk reduction.
To achieve this at global and regional levels, it is important:		
31 (c)	To promote cooperation between academic, scientific and research entities and networks and the private sector to develop new products and services to help to reduce disaster risk, in particular those that would assist developing countries and their specific challenges;	- This project involves the cooperation of people in the scientific community, academia and the private sector at an international level to potentially

		reduce disaster risk in the future (currently, it is a scoping project).
Priority 4: Enhancing Disaster Preparedness for Effective Response and to "Build Back Better" in Recovery, Rehabilitation and Reconstruction		
The steady growth of disaster risk, including the increase of people and assets exposure, combined with the lessons learned from past disasters, indicates the need to further strengthen disaster preparedness for response, take action in anticipation of events, integrate disaster risk reduction in response preparedness and ensure that capacities are in place for effective response and recovery at all levels. Empowering women and persons with disabilities to publicly lead and promote gender equitable and universally accessible response, recovery, rehabilitation and reconstruction approaches is key. Disasters have demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of a disaster, is a critical opportunity to "Build Back Better", including through integrating disaster risk reduction into development measures, making nations and communities resilient to disasters.		
To achieve this at national and local levels, it is important:		
33 (b)	To invest in, develop, maintain and strengthen people-centred multi-hazard, multisectoral forecasting and early warning systems, disaster risk and emergency communications mechanisms, social technologies and hazard-monitoring telecommunications systems; develop such systems through a participatory process; tailor them to the needs of users, including social and cultural requirements, in particular gender; promote the application of simple and low-cost early warning equipment and facilities; and broaden release channels for natural disaster early warning information;	- EO can be used to assist with multi-hazard forecasting and improving early warning systems. - This project respects the importance of tailoring systems to the needs of the users and thus, it undertakes a user need assessment for each of the countries.
33 (h)	To promote regular disaster preparedness, response and recovery exercises, including evacuation drills, training and the establishment of area-based support systems, with a view to ensuring rapid and effective response to disasters and related displacement, including access to safe shelter, essential food and non-food relief supplies, as appropriate to local needs;	- EO can be used to establish area-based support systems, as well as the locations of safe shelter. - EO can map 'safe' places for shelter and to store food. - EO can identify where relief supplies should be sent to and how to get those supplies to the people and their shelters. - EO can identify the safest travel routes dependent on different types of hazards/disasters. This can be utilised during the regular disaster preparedness, response and recovery exercises.
33 (l)	To consider the relocation of public facilities and infrastructures to areas outside the risk range, wherever possible, in the post-disaster reconstruction process, in consultation with the people concerned, as appropriate;	- EO can identify the areas outside the risk range. - EO can assist with assessing appropriate locations in regards to current and historical data. - EO can determine which construction material was resistant to the disaster.
33 (m)	To strengthen the capacity of local authorities to evacuate persons living in disaster-prone areas;	- EO maps can assist with evacuating people living in disaster-prone area. Therefore,

		maps should be readily available before the disaster strikes. - EO can also map areas that are less accessible to determine the damage created by the disaster. - EO satellite images can be used as a tool to conduct a damage assessment of different disasters (e.g. earthquakes, floods, volcanic eruption).
To achieve this at global and regional levels, it is important:		
34 (a)	To develop and strengthen, as appropriate, coordinated regional approaches and operational mechanisms to prepare for and ensure rapid and effective disaster response in situations that exceed national coping capacities;	- Regional approaches should include EO because it will strengthen preparation and ensure a more rapid and effective response.
34 (c)	To promote the further development of and investment in effective, nationally compatible, regional multi-hazard early warning mechanisms, where relevant, in line with the Global Framework for Climate Services, and facilitate the sharing and exchange of information across all countries;	- EO can be used to aid early warning mechanisms by providing real-time monitoring.
International Cooperation and Global Partnership		
40	In addressing economic disparity and disparity in technological innovation and research capacity among countries, it is crucial to enhance technology transfer, involving a process of enabling and facilitating flows of skill, knowledge, ideas, know-how and technology from developed to developing countries in the implementation of the present Framework.	- This scoping project will enhance knowledge of the stakeholders in developing countries. - EO technologies have the potential of being used in developing countries. - EO knowledge and the skill of using EO for monitoring, risk assessments and event/weather forecasting can be transferred from developed countries to developing countries.
43	African countries continue to face challenges related to disasters and increasing risks, including those related to enhancing resilience of infrastructure, health and livelihoods. These challenges require increased international cooperation and the provision of adequate support to African countries to allow for the implementation of the present Framework.	- This project is focusing on three African countries: Kenya, Rwanda and Uganda and scoping whether EO data can be used to improve the disaster risk reduction and management within these countries.

5. Main Findings

From the above review of the Sendai Framework, it has been discovered that EO can be integrated into this Framework and all of its priorities. Integrating EO into this Framework will contribute to the Framework's overall aim, which is: "The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. (UN, 2015: 12). Additionally, incorporating EO in the Framework will assist with addressing the

seven global targets. Furthermore, from the above review, it was seen that the use of EO can hugely benefit DRR, as well as all the phases of DRM (see **Figure 1**). Therefore, this section will provide a brief analysis by exploring EO under the three phases of DRM and then discuss the main findings of the review in specific relation to this scoping project.

5.1 Pre-Emergency Phase

As previously identified, the 'pre-emergency' phase involves the following elements: prevention, mitigation, preparedness and risk assessment(s). During this phase, EO can be beneficial in a variety of ways and can assist with each of the elements of this phase. The review of the framework indicated that technological measures, such as EO and GIS mapping of hazards can be used to **prevent, reduce and mitigate hazard exposure and vulnerability** to disaster. Additionally, EO can be **used as a tool** to assist with preventing and **reducing natural disaster risk** itself. For instance, EO can assist with environmental monitoring, meteorology and location-specific map making. These activities have the ability to reduce risk (e.g. satellite images can be used by to identify weather trends and forecast the weather based on current and historical EO data, which can greatly affect an at-risk community's impact from a flood, cyclone, hurricane or drought). EO can also **increase preparedness** to potential disasters and preparedness for response and recovery strategies.

Furthermore, in line with Priority 1 of the Sendai Framework, EO information and data can **improve the understanding of disaster risk**, especially in regards to the environment, and can contribute to disaster risk management. This data and information can be used for the following activities: **risk assessments**, exposure assessments, vulnerability assessments, hazard assessments, environmental impact assessments, improving communities' preparedness to a disaster, hazard monitoring, monitoring specific indicators, and responding to disasters more effectively. An advantage of this data and information is that it can be tailored for each activity and be user or location specific. Additionally, EO can be used to assist with **planning disaster risk reduction strategies**. For instance, EO can prioritise the most hazard-prone areas.

EO also has the ability to impact national and local frameworks of laws, regulations, public policies and disaster management plans. EO satellite images and subsequently, developed hazard maps can be used as highlighting disaster risks and hazard assessments in national and local frameworks of laws, regulations and public policies. This is due the fact that EO satellite images are a good tool, as well as an appropriate format to disseminate disaster risk information. This tool can be portrayed visually and therefore can make the risk information more comprehensive for decision makers, the general public and communities that are at risk. Moreover, a policy paper can be developed explaining exactly how EO can be used for DRR and what the benefits are of using EO as a tool for DRR.

Overall, from the Sendai Review, it has been seen that EO can be used in the pre-emergency phase in numerous beneficial ways and to different degrees. Therefore, it is suggested that knowledge and skills on EO be shared with governments and local authorities in developing countries that are prone to disasters. This would support the Sendai Framework's Priority 2: Strengthening Disaster Risk Governance to Manage Disaster Risk. EO has the ability to strengthen the technical and scientific capacity of a country, as well as capitalize on existing knowledge that is needed to manage disaster risk. Additionally, sharing EO data with local authorities and subsequently, providing RS and GIS training to them, can empower them. In

doing so it should improve their ability to undertake DRM at local level by working and coordinating with civil society, communities and indigenous peoples and migrants in disaster risk management at the local level. Furthermore, combining EO data with indigenous knowledge could **reduce disaster risks**, as well as improve the at-risk communities' resilience to disasters (by identifying coping/adaptation strategies). In fact, the UN (2015b:7) concurs with this and states that: "The combinations of satellite EO data with other traditional sources of data improve the quality of the information provided to end users, including decision-makers".

5.2 Emergency Phase

The emergency phase of a disaster, which involves the initial response, can be improved by integrating EO. For starters, by integrating EO and making EO accessible to the emergency responders, it can assist with risk-informed decision-making because it is a science-based tool that can provide risk information. EO can also **improve the response to disasters** by identifying/mapping the location of 'safe' places for shelter, for human settlement and to store food. Additionally, EO can be used to establish area-based support systems. For instance, it can identify where relief supplies should be sent to and how to get those supplies to the people and their shelters. It can also assist with determining the safest travel routes dependent on different types of hazards/disasters. EO maps can assist with evacuating people living in disaster-prone area. Moreover, prior to a disaster, up-to-date and detailed EO images can be created to identify where people with disabilities or life-threatening illnesses are and where the most closely located health facilities are. These images can show the relationship between these people and the vulnerable/hazard-prone areas and thus, be used in the occurrence of a disaster to assist responses to locate these people.

More uniquely, EO has the ability to extensively map localised areas that are less accessible (e.g. potentially due to flooding or earthquake damage). EO can assist with determining the damage created by disasters in such areas. Up-to-date EO satellite images can be used as a tool to conduct a detailed damage assessment of different disasters (e.g. earthquakes, floods, volcanic eruption). This ability of EO can be very helpful in determining whether assistance and relief is needed in these areas.

5.3 Post-Emergency Phase

The post-emergency phase, which include recovery, relief, rehabilitation and reconstruction, can benefit from EO in many different ways. EO can be integrated throughout many different points of the Sendai Framework to enhance the post-emergency phase of a disaster. Specifically, EO can be used to contribute to the Sendai Framework's Priority 4: Enhancing Disaster Preparedness for Effective Response and to "Build Back Better" in Recovery, Rehabilitation and Reconstruction. A few examples of how this can be done are as follows:

- EO can be used as a tool to **monitor recovery** in the built environment.
- Satellite EO can be used to assess the damage of a disaster (e.g. an earthquake) and can **determine where relief is needed**.
- EO can be used as a tool to undertake an environmental impact assessment.
- EO can assist with sustainable urban planning by providing up-to-date spatial information about urban areas (Musakwa and Van Niekerk, 2014), which **involves "building back better**".

- EO can be used to **identify 'safe' locations for reconstruction** by determining where infrastructure should be built by distinguishing flood-prone areas, elevated land, where agricultural resources are, and by identifying land contamination.
- EO can be used to **mainstream disaster risk into urban and rural development planning**, land degradation assessments and into management of the environment (e.g. rivers, forests, mountains, etc.).
- EO can assist with managing and monitoring ecosystems and mapping environmental and natural resources.

According to UN (2015b: 7), "[e]arth observations play an important role in making societies more resilient to natural hazards and more adaptive to climate change". From the review of the Sendai Framework, it was seen that this is true. Additionally, this supports the Sendai Framework's Priority 3: Investing in DRR for Resilience. Building the resilience of at-risk communities to natural hazards and disasters is very important and EO can be used as an aid. EO has the ability to improve the different phases of DRM but also the ability to aid with learning, specifically with learning from past disasters and re-occurring trends for improving the DRM for future disasters. Thus, using EO throughout rehabilitation and reconstruction can beneficial, especially when "building back better" the disaster preparedness and management plans. This would complete the DRM cycle (see **Figure 1**) by returning back to the pre-emergency phase after the post-emergency phase.

5.4 Specific Findings in Relation to This Project

This project is focusing on two African countries: Kenya and Uganda and is scoping whether EO data can be used to improve the DRR and DRM within these countries. From the review of the Sendai Framework, it was highlighted that the project has great potential to improve cooperation and collaboration across sectors and with relevant stakeholders at all levels (Principle Guideline E). Additionally, the project involves partnership between businesses, academia and governmental organisations. Moreover, this project has the potential to develop meaningful global partnerships between UK organisations/institutions and the government, NGOs and other key stakeholders from the African countries. Part of the Sendai Framework's Guiding Principles, it is important that cooperation between stakeholders and the Member States is improved. Encouraging the use of EO has the ability to enhance cooperation, especially transnational cooperation regarding DRR. This can be encouraged by sharing and transferring EO knowledge and the skill of using EO for monitoring, risk assessments and event/weather forecasting from developed countries to developing countries. Potentially, even a shared GIS platform can be developed to enhance the cooperation for DRR.

Another specific finding was that this project will enhance knowledge of the stakeholders in developing countries, while respecting the importance of tailoring systems to the needs of the users/countries. Therefore, this project will undertake a user need assessment for each of the countries by holding a workshop. Additionally, in line with the Sendai Framework, this project will promote and improve the dialogue among scientific and technological communities and other relevant stakeholders during the workshop to identify ways to improve the countries' DRR with the use of EO in the DRM phases.

References

CEOS (2012). 'Satellite Earth Observation for Disaster Risk Management'. *The Earth Observation Handbook*. Available at: http://www.eohandbook.com/eohb2012/case_studies_satellite_earth_observation_for_disaster_risk.html [accessed 10 February 2017].

Dyke, G., Gill, S., Davies, R., Betorz, F., Andalsvik, Y., Cackler, J., Dos Santos, W., Dunlop, K., Ferreira, I., Kebe, F., Lanboglia, E., Marsubara, Y., Nikolaidis, V., Ostoja-Starzewski, S., Sakita, M. and Verstappen, N. (2010) 'Dream project: Applications of earth observations to disaster risk management'. *Acta Astronautica*. Vol. 68. Pp. 301-215. Available at: http://doi.org.ezproxy3.lib.le.ac.uk/10.1016/j.actaastro.2010.06.018 [accessed 31 March 2017].

ESA (European Space Agency) (2015). *Satellite Earth Observations in Support of Disaster Risk Reduction: Special 2015 WCDRR Edition*. Available at: http://www.eohandbook.com/eohb2015/files/CEOS_EOHB_2015_WCDRR.pdf [accessed 10 February 2017].

GEO (2017). 'FAQ'. *GEO: Group on Earth Observations.* Available at: https://www.earthobservations.org/g_faq.html [accessed 24 February 2017].

Global Pulse (2012). *Big Data for Development: Challenges & Opportunities*. New York: Global Pulse. Available at: http://www.unglobalpulse.org/sites/default/files/BigDataforDevelopment-UNGlobalPulseJune2012.pdf [accessed 10 February 2017].

GTR (2017a). 'Mapping Flood Risks with Future Flow and Precipitation'. *Gateway to Research*. Research Councils UK. Available at: http://gtr.rcuk.ac.uk/projects?ref=NE%2FN020324%2F1# [accessed 31 March 2017].

GTR (2017b). 'Landslide Multi-Hazard Risk Assessment, Preparedness and Early Warning in South Asia: Integrating Meteorology, Landscape and Society'. *Gateway to Research*. Research Councils UK. Available at: http://gtr.rcuk.ac.uk/projects?ref=NE%2FP000649%2F1# [accessed 31 March 2017].

Guo, H., Zhang, L. and Zhu, L. (2015). 'Earth observation big data for climate change research'. *Advances in Climate Change Research*. 6 (2): 108-117. Available at: http://www.sciencedirect.com/science/article/pii/S1674927815000519 [accessed 17 February 2017].

Home Office (1998). *Dealing with Disaster*. 3rd Edition. London: Cabinet Office. Available at: http://webarchive.nationalarchives.gov.uk/20050523205851/http:/ukresilience.info/contingen cies/dwd/dwdrevised.pdf [accessed 28 March, 2015].

IFRC (2000). 'Preparedness planning'. *Disaster Preparedness Training Program*, June. Available at: https://www.ifrc.org/Global/Preplan.pdf [accessed 17 February 2017].

Khan, H., Vasilescu, L. and Khan, A. (2008). 'Disaster management cycle: A theoretical approach'. *Marketing & Management Journal*: 43-50. Available at: http://www.mnmk.ro/documents/2008/2008-6.pdf [accessed 10 February 2017].

Moe, T. and Pathranarakul, P. (2006), 'An integrated approach to natural disaster management'. *Disaster Prevention and Management: An International Journal*. 15 (3): 396-413. Available at: www.emeraldinsight.com/0965-3562.htm [accessed 29 July 2015].

Musakwa, W. and Van Niekerk, A. (2014). 'Earth observation for sustainable urban planning in developing countries: Needs, trends and future directions'. *Journal of Planning Literature*. 30 (2): 149-160. Available at: http://journals.sagepub.com/doi/full/10.1177/0885412214557817 [accessed 16 February 2017].

Negula, I. D., Sofronie, R., Virsta, A. and Badea, A. (2015). 'Earth observation for the world cultural and natural heritage'. *Agriculture and Agricultural Science Procedia*. 6 (2015): 438-445. Available at: http://www.sciencedirect.com/science/article/pii/S2210784315002478 [accessed 16 February 2017].

The World Bank (2010). *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention*. Washington: The International Bank for Reconstruction and Development. Available at: https://www.gfdrr.org/sites/gfdrr/files/publication/NHUD-Report_Full.pdf [accessed 10 February 2017].

UN (2002). *United Nations Response to Natural Disasters: Mandates, Roles and Mechanisms of UN Entities in the Disaster Management Cycle*. New York: United Nations.

UN (2015a). *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva: UNISDR. Available at: http://www.unisdr.org/we/coordinate/sendai-framework [accessed 10 February 2017].

UN (2015b). *Earth Observations in Support of National Strategies for Disaster-Risk Management: A Synergy Framework for the Integration of Earth Observation Technologies into Disaster Risk Reduction*. UN World Conference on Disaster Risk Reduction, Final Issue, 25 February 2015, Sendai, Japan. Available at: https://www.earthobservations.org/documents/meetings/201503_wcdrr_iii/201503_wcdrr_iii_white_paper_eo_drr.pdf [accessed 17 February 2017].

UNFCCC (2006). *United Nations: Framework Convention on Climate Change*. Bonn: Climate Change Secretariat. Available at: https://unfccc.int/resource/docs/publications/handbook.pdf [accessed 10 February 2017].

UNISDR (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*, Geneva: UNISDR. Available at: http://www.preventionweb.net/files/7817_UNISDRTerminologyEnglish.pdf [accessed 10 February 2017].

UNISDR (2015). 'World Conference adopts new international framework for disaster risk reduction after marathon negotiations'. *UNISDR News Archive*. 18 March. Available at: https://www.unisdr.org/archive/43289 [accessed 10 February 2017].

UNISDR (2017). 'What is Disaster Risk Reduction?'. *UNISDR: The United Nations Office for Disaster Risk Reduction*. Available at: https://www.unisdr.org/who-we-are/what-is-drr [accessed 10 February 2017].

UN-SPIDER (2014). 'Glossary: Disaster management cycle'. *UN-SPIDER Knowledge Portal*. Available at: http://www.un-spider.org/glossary/disaster-management-cycle [accessed 16 February 2017].