World Meteorological Organization
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A Disaster Risk Reduction Roadmap for the World Meteorological Organization

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Section	***Page & paragraph / bullet / list item within the section***	***Comments and textual suggestions***
Preamble		
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1.1 Rationale and Background		
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Draft, 20 January 2016

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Executive summary

To be completed

The WMO Disaster Risk Reduction Roadmap provides an initial overview of the WMO Disaster Risk Reduction 'journey' from 2015 through until 2030 (four WMO inter-sessional periods). The Roadmap document will provide an insight into the rationale behind the development of the Roadmap, will describe the underpinning methodology of the activity design and implementation.

Preamble

This zero-draft of a Disaster Risk Reduction (DRR) Roadmap for the World Meteorological Organization (WMO), hereafter referred to as the Roadmap, was developed by the WMO Secretariat, assisted by Members (Canada, China, Japan, United Kingdom, and the United States of America), for consideration of the Seventeenth Session of the World Meteorological Congress (Cg-17) in May 2015, at the request of the WMO Executive Council, at its sixty-sixth session (EC-66) in June 2014. Specifically, EC-66 had requested the WMO Secretariat, "*in consultation with Members, to urgently develop a WMO DRR roadmap of prioritized and realistically achievable activities and deliverables that are consistent with the WMO Strategic and Operating Plans as well as the work plans for relevant WMO programmes and projects*". In addition, EC called for a clear identification of the role of National Meteorological and Hydrological Services (NMHSs) and WMO, working with their partners, in the implementation of international frameworks and planning processes, such as the *Sendai Framework for DRR 2015-2030*[1], the successor to the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA)*[2]. The full text of Resolution 4.2/1 (EC-66) *WMO DISASTER RISK REDUCTION ROADMAP*, which defines the purpose of the document at hand, is detailed in Annex I.

The EC request came timely, as 2015 marked a pivotal year in the global development agenda: The Sendai Framework was adopted at the *Third United Nations World Conference on Disaster risk Reduction (WCDRR)* in Sendai, Japan, in March 2015. The *Third International Conference on Financing for Development* in Addis Ababa, Ethiopia, in July 2015)[3] resulted in an intergovernmentally negotiated and agreed outcome on financing sustainable development. In October 2015, the outcome document *Transforming our world: the 2030 Agenda for Sustainable Development* of the *United Nations summit for the adoption of the post-2015 development agenda* in New York, USA, in September 2015. Its set of *Sustainable Development Goals (SDGs)*[4] supersedes the *Millennium Development Goals (MDGs)*, of which disaster risk management (DRM) for achieving DRR is an integral part. In addition, at the *21st Session of the Conference of the Parties (COP21/CMP11)*[5] to the United Nations Framework Convention on Climate Change (UNFCCC), in December 2015 in Paris, France, 195 countries adopted with the *Paris Agreement* the first-ever universal, legally binding global climate deal. It will be implemented from 2020 onwards. Provisions of this treaty include measures to reduce and transfer disaster risk and how to deal with loss and damage if climate change mitigation and adaptation are not sufficient. This rare alignment of international policy processes with national government, private sector, and civil society interests is an opportunity to position DRM as a cornerstone in the efforts to foster DRR, climate change adaptation (CCA) and resilience as key components of sustainable development.

In addition to the global development agenda an increasing number of actors are demanding access to timely multi-hazard warnings and information, both on weather and climate time scales, in order

[1] http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf, until its adoption at WCDRR called "post-2015 framework for DRR".

[2] http://www.unisdr.org/we/coordinate/hfa

[3] http://www.un.org/esa/ffd/overview/third-conference-ffd.html

[4] http://sustainabledevelopment.un.org/?menu=1300

[5] http://www.cop21.gouv.fr/en

to better inform their own tactical and strategic decision making. For many of these actors the demand for information is being successfully realised through WMO Members. However, this demand is also being served by third-party organisations including regional bodies, the private sector and NGOs. On the grounds that this can undermine the role of the local NMHS and lead to a confused message for decision makers, it is therefore important that this Roadmap also acts as a vehicle by which WMO looks to improve coordination and collaboration in respect of the global response to the current DRR focus in the global development agenda outlined above.

In further reading this draft, it is important to clarify what is meant by "roadmap". The Roadmap at hand is first and foremost a document that can be used by both WMO Members and the external side to understand how NMHSs can contribute to increasing the resilience of communities, nations, regions, and the world under the above-mentioned frameworks, through a coordinated WMO-wide plan of action for DRR. It is neither a reference document for the theoretical or practical aspects of DRR nor a separate project or programme. However, it will discuss the activities required to address DRR as one of the seven WMO priority areas in *WMO Strategic Plan 2016-2019*[7]. Therefore, a key element is to utilize existing WMO mechanisms and plans wherever possible, above all the WMO DRR Programme, and identify synergies to leverage WMO activities and projects to realise a DRR vision for NMHSs and the Organization and, if appropriate, forge links to external initiatives. In this way, the document is a means for the cross-cutting DRR Programme to achieve its goals. This comprehensive, cross-cutting set of activities will also contribute to the realisation of other WMO priorities such as the *Global Framework for Climate Services (GFCS)*[8] and capacity development.

The Roadmap will cover four inter-sessional periods of WMO, corresponding to the 15 years lifetime of the Sendai Framework, and will align closely with a number of existing global conventions and international development frameworks under development (e.g. on humanitarian and urban issues), as well as WMO frameworks and strategic documents (see Section 3.1.3). The timescales involved require the Roadmap to be a "living" document which will define an initial set of activities and identify key milestones along this journey towards a "DRR service-ready" NMHS and Organization over all. Over the course of time the DRR landscape is certain to change and this initial document will necessitate regular updates and therefore further endorsement from the WMO decision-making bodies. Key elements of the Roadmap will be described in more detail, i.e. how priority activities will be identified, designed, built, developed, and delivered. However, while some activities will be clear and therefore easier to define, others will mature during the course of the Roadmap.

[7] https://www.wmo.int/pages/about/spla_en.html

[8] http://gfcs.wmo.int/

1 Introduction

1.1 Rationale and background

It is well documented that high-impact weather events and climate extremes, both rapid onset such as hurricanes and slow onset such as droughts, have devastating effects throughout the world, resulting in injury and loss of life, displacement of people, and destruction of communities. The personal and social costs of these losses are tremendous and the financial impacts on the economy, are enormous (Figure 1).

The Sendai Framework states that over the lifetime of the *HFA*, "*disasters have continued to exact a heavy toll, and as a result the well-being and safety of persons, communities and countries as a whole have been affected. Over 700 thousand people lost their lives, over 1.4 million were injured and approximately 23 million were made homeless as a result of disasters. Overall, more than 1.5 billion people were affected by disasters in various ways. Women, children and people in vulnerable situations were disproportionately affected. The total economic loss was more than US$ 1.3 trillion. In addition, between 2008 and 2012, 144 million people were displaced by disasters.*"

The Global Assessment Report on DRR 2015[11] (GAR15) states that "*despite success in reducing mortality and economic loss in certain countries and cities and for some hazards[12], overall disaster risk is still increasing. … One especially alarming development is that both the mortality and economic loss associated with smaller-scale, recurrent localized disasters are trending up*" (Figure 2).

This rise in losses can be partly attributed to the increasing vulnerability of people and infrastructure to the consequences of weather and climate extremes due to e.g. population growth – particularly in flood plains and coastal regions, urbanization and the rise of megacities, economic inter-dependencies, and obsolescence of infrastructures. Weather and climate extremes are contributing to ever larger economic losses and in some cases slower economic post-disaster recovery. These social and economic vulnerabilities will continue to exist and – most likely – grow, and together with prevailing high-impact weather such as tropical storms will continue to pose elevated risks to the safety of lives and property, particularly in developing and least developed countries and in small island developing states (SIDS). Typhoon *Haiyan* that devastated the Philippines in 2013 is a stark reminder of this ongoing reality.

It is therefore vital that NMHSs continue to increase their technical capacity and also their engagement with national decision makers in order to better serve the needs of their respective DRR communities across all time and spatial scales. In order to respond to this need, WMO continues to make DRR one of its highest priorities.

[11] http://www.preventionweb.net/english/hyogo/gar/2015/en/home/index.html

[12] This has been due to advancements in hydrometeorological science and technology, engagement with national DRR platforms which have led to improvements in early warning systems, and preparedness of communities.

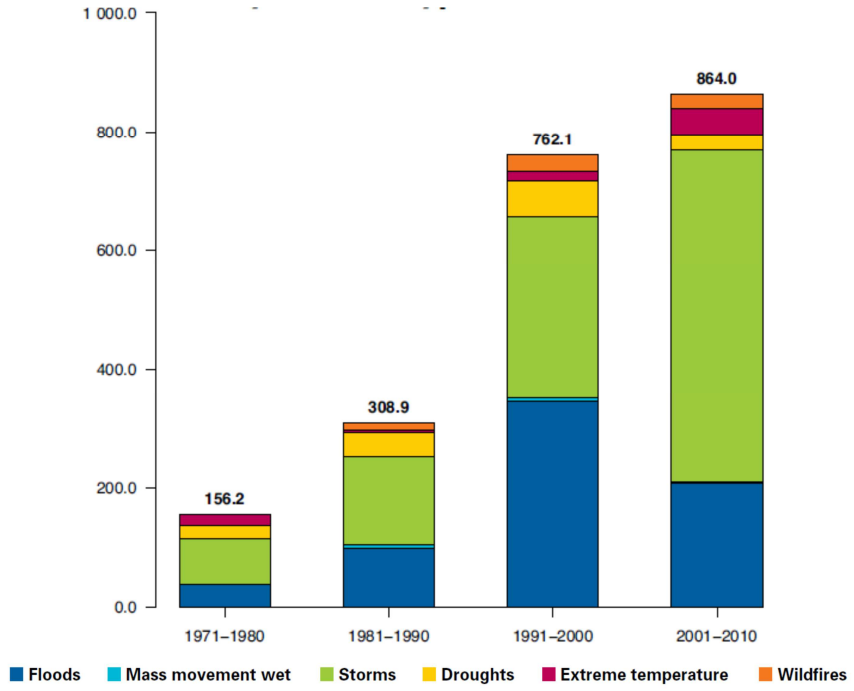

Figure 1: Recorded economic losses by decade by hazard type (1971-2010), in US$ billion, adjusted to 2012 (Source: WMO and CRED, 2014[13])

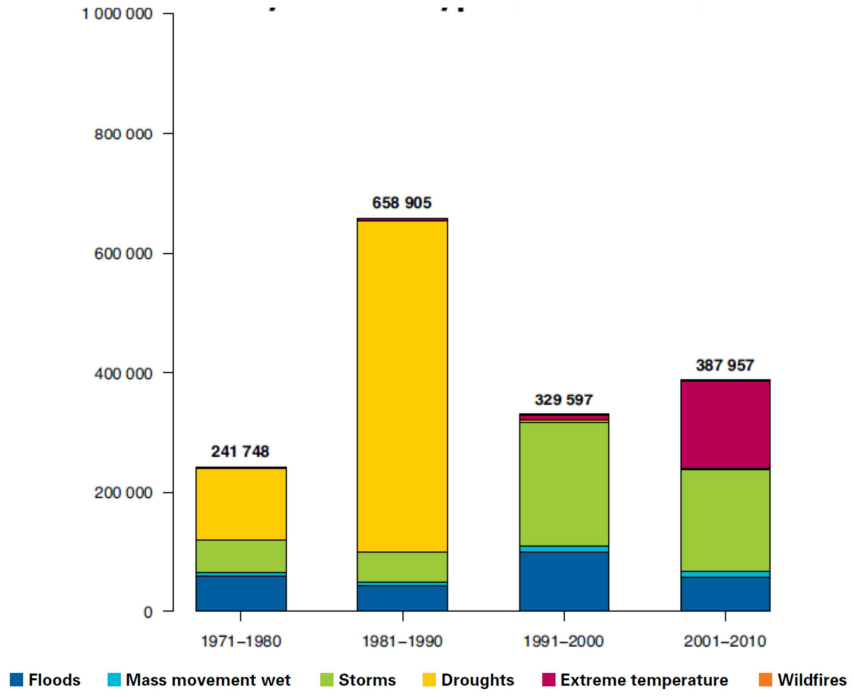

Figure 2: Number of reported deaths by decade by hazard type (1971-2010) (Source: WMO and CRED, 2014)

[13] WMO and CRED, 2014: Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2012). Geneva (available at: http://library.wmo.int/opac/index.php?lvl=notice_display&id=16279#.VTo1JmOfgRo) Note: "mass movement wet" includes any type of downslope movement of earth materials (such as snow avalanches, debris and mud flows, and rockfalls) that involves the occurrence, movement, and distribution of surface and subsurface water.

1.2 Disaster risk reduction – a high priority for WMO

In the current *WMO Strategic Plan 2012-2015*[14], DRR is one of the five strategic priority areas with the expected results of enhanced capabilities of Members to (1) reduce risks and potential impacts of hazards caused by weather, climate, water and related environmental elements and (2) produce better weather, climate, water and related environmental information, predictions, warnings, and services to support DRR and climate adaptation strategies. For the following it may be helpful to recall, or define, what is meant by DRR in the context of WMO.

Over the years a number authoritative bodies have devised definitions of DRR (e.g. UNISDR 2009[15] & 2015[16], IPCC 2012[17]). Definitions aside, DRR is mostly recognized as a series of activities known as **disaster risk management (DRM)** which require multidisciplinary expertise involving numerous actors, which when implemented, contribute towards the avoidance, reduction, and transfer of the risks and adverse impacts of disasters and an increase in **resilience**. As a prerequisite this involves **risk assessment** – including hazard and risk identification, analysis and evaluation – which is different in the recovery / prevention (or "cold") phase and the preparedness / response (or "hot") phase of DRM. Equipped with such risk information, countries can develop **risk reduction** strategies and activities that are frequently presented as a cycle or upward winding spiral, including four components: **prevention, preparedness, response and recovery.** In the preparedness phase, MHEWS help especially to reduce casualties. Over the medium and long-term, i.e. in the prevention and recovery phases, sectoral planning (such as land zoning, infrastructure development, water resource management, and agricultural planning) reduces economic losses and builds livelihood resilience. Another aspect is response, e.g. in humanitarian planning and assistance. Residual risks that cannot be effectively reduced can be addressed by **risk transfer** and disaster risk financing mechanisms such as weather-indexed insurance.

Figure 3 provides an overview of how meteorological and climate information is integrated within a DRM cycle with reference to specific meteorological phenomena[18]. However, in the context of the Roadmap it is important to ask the following questions:

- **What does DRR mean to a NMHS?** – For a NMHS, DRR is the desirable outcome/end state of effective service delivery that identifies, provides and communicates hazard and risk information in such a way that the appropriate stakeholders, decision-makers, and general public can take actions to reduce losses and disaster risks and ultimately increase resilience.

[14] http://www.wmo.int/pages/about/documents/1069_en.pdf

[15] UNISDR (2009). UNISDR Terminology on Disaster Risk Reduction. Geneva, Switzerland: United Nations Office for Disaster Risk Reduction, available at: http://unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

[16] UNISDR (2015). Making Development Sustainable: The Future of Disaster Risk Management. Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: United Nations Office for Disaster Risk Reduction, available at: http://www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/GAR2015_EN.pdf

[17] IPCC (2012). Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK, and New York, NY, USA, pp. 555-564, available at https://www.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf

[18] Hellmuth M.E., Mason S.J., Vaughan C., van Aalst M.K. and Choularton R. (eds) 2011. A Better Climate for Disaster Risk Management . International Research Institute for Climate and Society (IRI), Columbia University, New York, USA. Available at: http://iri.columbia.edu/wp-content/uploads/2013/07/CSP3_Final.pdf.

- **What does DRM mean to a NMHS?** – For a NMHS, DRM includes the processes by which a NMHS, working in partnership with other stakeholders, understands requirements, risks, and vulnerabilities and delivers effective and meaningful services which contribute to DRR.
- **What is the role of NMHSs in DRM?** – Keeping in mind that DRR is the desired outcome and DRM is the process through which DRR is achieved, a NMHS's role is to (i) provide a single authoritative voice through service delivery for early warning for multiple (mostly) hydrometeorological hazard warnings and information; (ii) inform/mobilize/partner with academic institutions and other experts that contribute to this information; and (iii) educate/raise awareness of the general public and tactical and strategic decision-making authorities (governmental and non-governmental entities) to understand hazards and related warnings (as well as uncertainties, technical requirements, etc.).

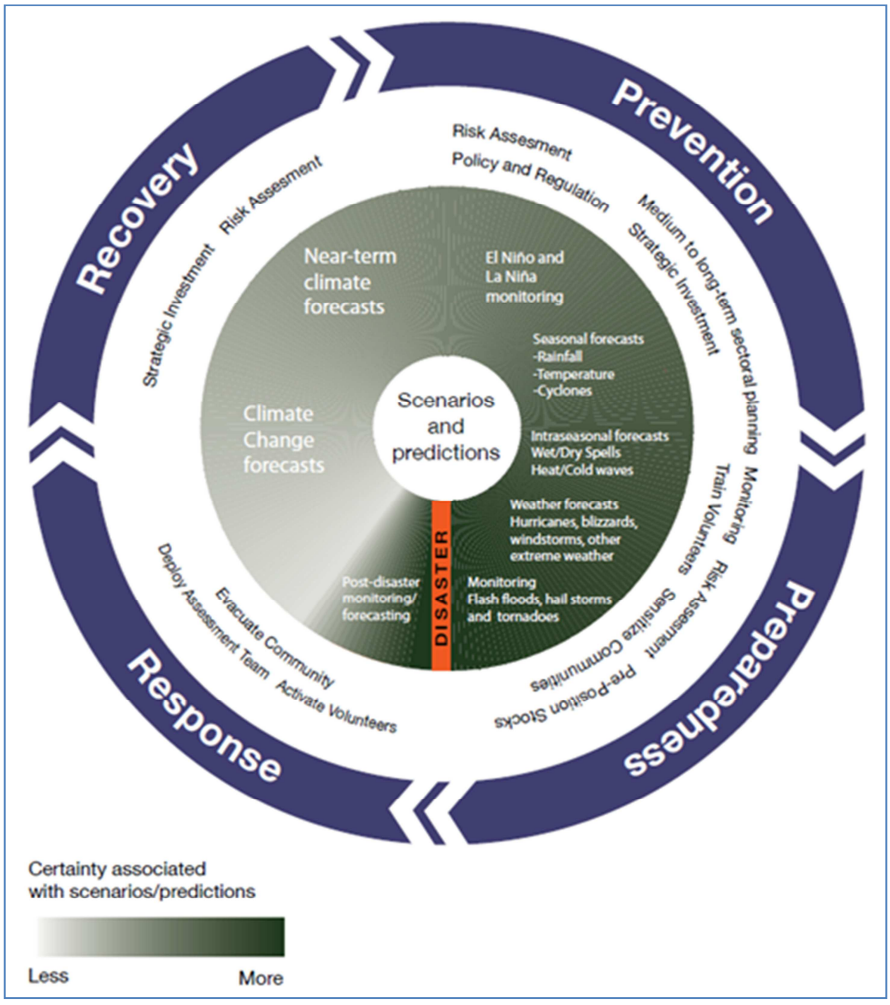

Figure 3: Incorporating climate information into the disaster risk management cycle[19]

Figure 4 presents a high-level overview of the pivotal role a NMHS can play in its national DRR governance and demonstrates both routine service delivery and more DRR-specific activities. One of the key points to note here, and one which is often missed during DRR discussions, is that a NMHS

[19] (Source: Hellmuth et al., 2011)

has a role to play across all timescales, from weather-specific early warnings through to slower onset seasonal or climate-service related information.

In this context, the Fourteenth World Meteorological Congress (Cg-XIV) in 2003[20] established the WMO DRR Programme to provide an organization-wide coordination framework for DRR with the **vision to enhance the contributions of NMHSs, in a more cost-effective, systematic and sustainable manner, to the protection of lives, livelihoods and property, through enhanced capabilities and cooperation in the field of DRR at national to international levels.** The scope of the Programme is underpinned by the HFA, which shifted the traditional focus of post-disaster humanitarian response to a more comprehensive approach involving prevention and preparedness measures.

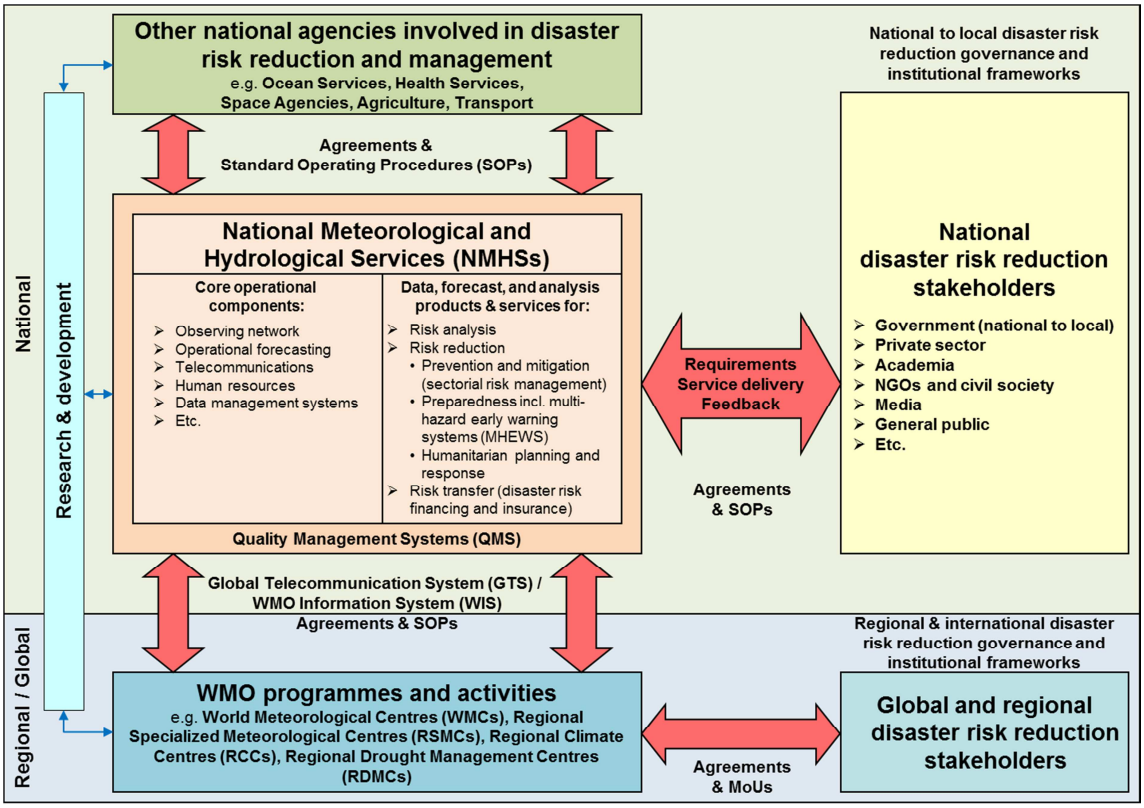

Figure 4: Overarching framework of the WMO Disaster Risk Reduction Programme for development and delivery of products and services by National Meteorological and Hydrological Services and related partners to support national disaster risk management (Source: WMO DRR Work Plan 2012-2015[21], updated)

The realizable / expected benefits of the Roadmap to WMO Members and corresponding NMHSs are in alignment with the WMO DRR Programme's goals[22], approved by Congress XV in 2011:

1. Development, improvement and sustainability of early warning systems (EWS) in particular related to scientific and technical infrastructures, systems and capabilities for research,

[20] Resolution 29 (Cg-XIV). Note that the original name in 2003 was "Natural Disaster Prevention and Mitigation Programme" which was changed to "DRR Programme" by the Fifteenth World Meteorological Congress (Cg-XV) in 2007.

[21] http://www.wmo.int/pages/prog/drr/index_en.html

[22] http://www.wmo.int/pages/prog/drr/aboutDRRProg_en.html

observing, detecting, forecasting and warnings of weather-, water- and climate-related hazards;

2. Development, improvement and sustainability of standardized hazard databases and metadata, systems, methods, tools and applications of modern technologies such as geographical information systems for recording, analysing and providing hazard information for risk assessment, sectoral planning, risk transfer and other informed decision-making;
3. Development and delivery of warnings, specialized forecasts and other products and services that are timely, understandable to those at risk and driven by requirements of disaster risk reduction decision processes and operations engaging socio-economic sectors;
4. Stimulate a culture of resilience and prevention through strengthening of capacities for better integration of meteorological, hydrological and climate products and services in disaster risk reduction across all socio economic sectors, such as land use planning and infrastructure design and continued public education and outreach campaigns; and
5. Strengthening cooperation and partnerships of WMO and NMHSs in national, regional and international user forums, mechanisms and structures for implementation of disaster risk reduction.

What is immediately clear from the DRR / DRM descriptions listed above is the importance of service delivery in the DRM cycle and therefore all of the activities described in later sections will align with the six elements of the WMO Strategy for Service Delivery[23] (Figure 5). In fact this means that there is a strong argument for considering DRR across all elements of the service delivery cycle.

The development of DRM approaches by NMHSs to support DRR should thus follow basic principles in service development as defined in the WMO Strategy for Service Delivery where establishing user engagement and partnerships ensures that the development and delivery of services will respond to needs and be continually monitored and improved. The success of DRR service delivery depends on these factors as well as on respective capacity development.

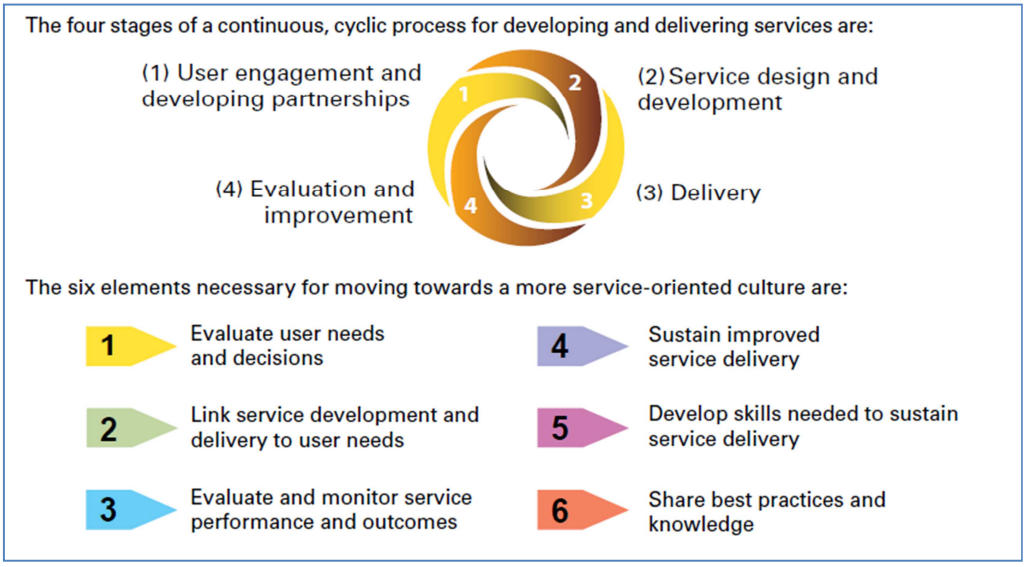

Figure 5: Stages and elements of the WMO Strategy for Service Delivery (Source: WMO, 2014)

[23] http://www.wmo.int/pages/prog/amp/pwsp/documents/WMO-SSD-1129_en.pdf

1.3 Objectives of the Roadmap

During the side event on the Roadmap on the occasion of the 2nd meeting of the Intergovernmental Board on Climate Services (IBCS-2) in November 2014, the WMO Secretariat presented a vision for a "DRR services-ready NMHS" that would be – supported by WMO as a whole – able to:

- Provide user-driven DRR services to several sectors and for various spatial and temporal scales;
- Co-produce and co-deliver such DRR services through strong partnerships and joint efforts for standardized preparedness and response plans.
- Contribute to and use impact-based forecasts and risk-informed warnings of multiple hazards to inform national DRR decision-making within the framework of multi-hazard early warning systems (MHEWS);
- Fully link vulnerability and exposure data to hazard information in data processing, production, and service delivery; and,
- Advance and apply science (natural and social) and technology to support DRR services.

This DRR strategy – the Roadmap – will therefore look to guide WMO Members and the wider WMO family[24] through a journey over the next 15 years to enhance service delivery to national (and in some cases regional and global) DRR stakeholders and therefore play an increasing role in improving long-term disaster and climate resilience. Through the WMO DRR Programme, the Roadmap will:

- Provide a framework for WMO Members to enhance NMHSs' contributions to national DRR efforts;
- Provide a mechanism to enhance WMO programmatic coordination and collaboration in respect of DRR;
- Reference developments in capability such as impact-based forecasting and risk-informed warnings of multiple hazards;
- Identify both tactical and strategic opportunities to enhance the role of hydrometeorology and therefore of NMHSs and WMO in global and regional DRR fora (including coordinated and focused engagement with the international DRR stakeholder community, e.g. the United Nations system, regional and sub-regional organizations[25], the private sector, charities, NGOs, etc.) and in the implementation of relevant international frameworks and processes.

In addition, the Roadmap will describe requirements both in terms of non-monetary resources and funding needed to support its further development and implementation.

With reference to the principal objectives outlined by EC-66 (Annex I) and Cg-17 (Annex II), and based on the achievements by WMO Members prior to and over the lifetime of the *HFA*, the Roadmap will provide a basis for WMO's contribution to the wider DRR-related post-2015 agenda, specifically the *Sendai Framework*[26], the *DRR Priority of the Global Framework for Climate Services (GFCS)*[27], and the *United Nations Plan of Action on DRR for Resilience*[28]. Facilitated by the WMO DRR

[24] Regional Associations (RAs), Expert Teams etc.

[25] For example, the European Union (EU), the Economic Community of West African States (ECOWAS), etc.

[26] http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf

[27] http://www.gfcs-climate.org/disaster_risk_reduction

Programme, the Roadmap will serve as guidance to Members, the WMO operational and research networks, and the Secretariat, for their support to local, national, regional, and global DRR activities under these frameworks.

The main focus will be on guiding WMO's contribution to the implementation of the Sendai Framework (specifically through its four Priorities for Action), in which States call to 1) strengthen the understanding and 2) management of risk, 3) invest in DRR, and 4) enhance disaster preparedness for effective response, recovery, rehabilitation, and reconstruction ("build back better"); and in which States define the role of stakeholders and of international cooperation and global partnership.

To support the assessment of global progress in achieving outcome and goal of the Sendai Framework, seven global targets (Annex III) were agreed that will be measured at the global level by appropriate indicators. Moreover, national targets and indicators will contribute to the achievement of the outcome and goal of this Framework.

Since the NMHSs' main role within their national DRR efforts, with their unique operational capacities (often 24/7), is to develop and deliver multi-hazard early warnings, the Roadmap will specifically address the establishment and strengthening of **national MHEWS** (relating to target 7) as well as **WMO's role in international cooperation in support of the implementation of the Sendai Framework** (target 6), which would support each NMHSs' contribution to achieving all seven targets and help to implement the commitments made by the United Nations system and Member States in their statements, key messages, and action plans.

1.4 Structure of the document

Following this introduction the next chapters present the main section of the Roadmap:

- Benefits of the Roadmap to members (Section 2);
- The identification and design of priority activities per thematic area aligned with the Sendai Framework and per activity pillar aligned with the WMO Strategy for Service Delivery, including information on other internal and external linkages and interactions, future consultations, regular updates, etc. (Section 3);
- The proposed initial priority activities for the intersessional period 2016-2019, including the establishment of a baseline, prioritization, supporting the four Priorities for Action of the Sendai Framework, and potential future activities in the long term (Section 4);
- The implementation framework and approach, including governance, implementation and user-interface mechanisms and their roles and responsibilities; timeline / timeframes, financial and resources considerations, communication and outreach, monitoring and evaluation, etc. (Section 5); and,
- Concluding remarks and annexes as well as a link to the WMO DRR Work Plan 2016-2019.

[28] http://www.preventionweb.net/files/33703_actionplanweb14.06cs1.pdf (to be updated in 2016)

2 Benefits of the Roadmap to Members

Recognising that capacities for NMHSs to service their national DRR mechanisms vary, the implementation of the Roadmap will help NMHSs to increase their engagement and capacity to support their national DRR agenda and ultimately contribute towards increased resilience. While more specific social, economic, and environmental benefits are described below, some of the key benefit areas to Members are increased resilience through:

- Reduced loss to lives and livelihoods;
- Reduced economic losses;
- Improved sectoral planning, including increased use of climate services for long-term strategic planning;
- More effective EWS and MHEWS; and,
- Coordinated cross-organisational activities in DRR.

Some of the key benefit areas to the corresponding NMHSs are to:

- NMHSs are placed at the heart of their national DRR governance mechanisms, with the Roadmap providing guidance to NMHSs how to effectively engage in these mechanisms;
- Increased sustainability of the NMHS (in terms of funding and also after having been affected by disasters themselves);
- Identified areas of good practice where NMHSs (Members) can learn from tested methods of others; and,
- Promotion of training and capacity development for NMHSs.

2.1 Social benefits

NMHSs and other institutions of WMO Members contribute to the safety and well-being of society through their efforts to provide information on the impacts on lives and livelihoods of natural hazards, to improve the safety of transport on land, at sea, and in the air and to contribute to human and environmental health outcomes.

Effective DRR related to hydrometeorology is based on science-based weather, climate, and water information about potential hazards. Seasonal climate forecasts are useful for strategic and tactical planning of climate-sensitive activities, while the analysis of multi-year hazard patterns and trends, combined with climate change scenarios, can underpin longer-term strategic planning. Improving operational climate services through the GFCS will enhance national capabilities to support climate-smart decision-making. This will further strengthen the resilience of society to longer-term climate variability and change. Critical to success are the service delivery interactions with the community of users, including open access to global weather, water, and climate data, knowledge, and impact-relevant products and services. Climate-related risk knowledge on monthly to decadal timescales helps institutions and organizations at global, regional, and national levels to develop risk management plans based upon EWS and preparedness, medium- and long-term sectoral planning, and utilization of weather-indexed insurance and financing mechanisms to reduce the impacts of disasters at various levels (corresponding to the original thematic areas of the DRR Work Plan 2012-2015).

2.2 Economic benefits

Accurate, timely and impact-oriented weather, climate, water and related environmental services from Members, in particular from their NMHSs, make a significant contribution to economic stability, efficiency, and growth in many sectors. Examples include water resource management, food production, and aviation and marine transportation and energy (especially hydro-, solar- and wind-power). Early warning services and forecasts inform economically-driven decisions that mitigate the effects of meteorological and hydrological hazards.

WMO Members also monitor space weather conditions and processes (e.g. solar flares, geomagnetic storms etc.) which can have significant impacts on economic sectors such as aviation, telecommunications, satellite operations, and electricity transmission. Governments and the aviation industry rely on WMO and its Members to provide advice on the dispersion of volcanic ash, a significant hazard to aircrafts, with associated downstream impacts on numerous economic sectors. In response to nuclear or industrial accidents, WMO works in close collaboration with agencies such as the International Atomic Energy Agency (IAEA) and the Wold Health Organization (WHO) to provide advice and information to reduce impacts.

2.3 Environmental benefits

WMO and its Members monitor the environment over time, providing insight into possible impacts on the world's climate, food and water security, natural ecosystems, and human health. Changes are occurring in rainfall and temperature, the chemical composition of the atmosphere, surface and groundwater availability, land cover and soil condition, the temperature and chemical balance of the oceans, and pollutants in the air, water, and soil. Subtle changes in these parameters can have profound consequences for ecosystems, biodiversity, and food production systems.

2.4 Focused coordination of DRR activities across WMO

DRR is a priority area for WMO and is a consistent theme for all NMHSs and throughout many WMO RAs, TCs, TPs and projects. As such it is important that DRR is addressed in a coordinated manner. This Roadmap will not only help guide WMO's approach to DRR but will also help coordinate DRR activities across WMO and can act as a focal point for international DRR initiatives and service providers (providing a 'one stop shop' in terms of information on linkages).

3 Identification and design of priority activities

The previous sections have described both the requirements and the rationale behind the development of a WMO DRR Roadmap. In this section, the principles behind the identification and design of priority activities as the key elements of the Roadmap will be described - in terms of generic and project-specific activities per **thematic areas** (aligned with the Sendai Framework), **activity pillars (aligned with the WMO Strategy for Service Delivery),** other internal and external linkages and interactions, and future consultations and regular updates.

Figure 6 provides a schematic overview of the Roadmap, highlighting how the latter will look to identify activities which can then be **delivered by existing (and to be expanded and complemented by DRR-specific components) and planned or potential future programmes, projects, and frameworks, and where appropriate in partnership with DRR-related 3rd-party initiatives** (e.g. through leveraging their respective plans, such as the UNFCCC's National Adaptation Programmes for Action (NAPAs) for Least Developed Countries (LDCs) which could form an important component of increasing national DRR capacity).

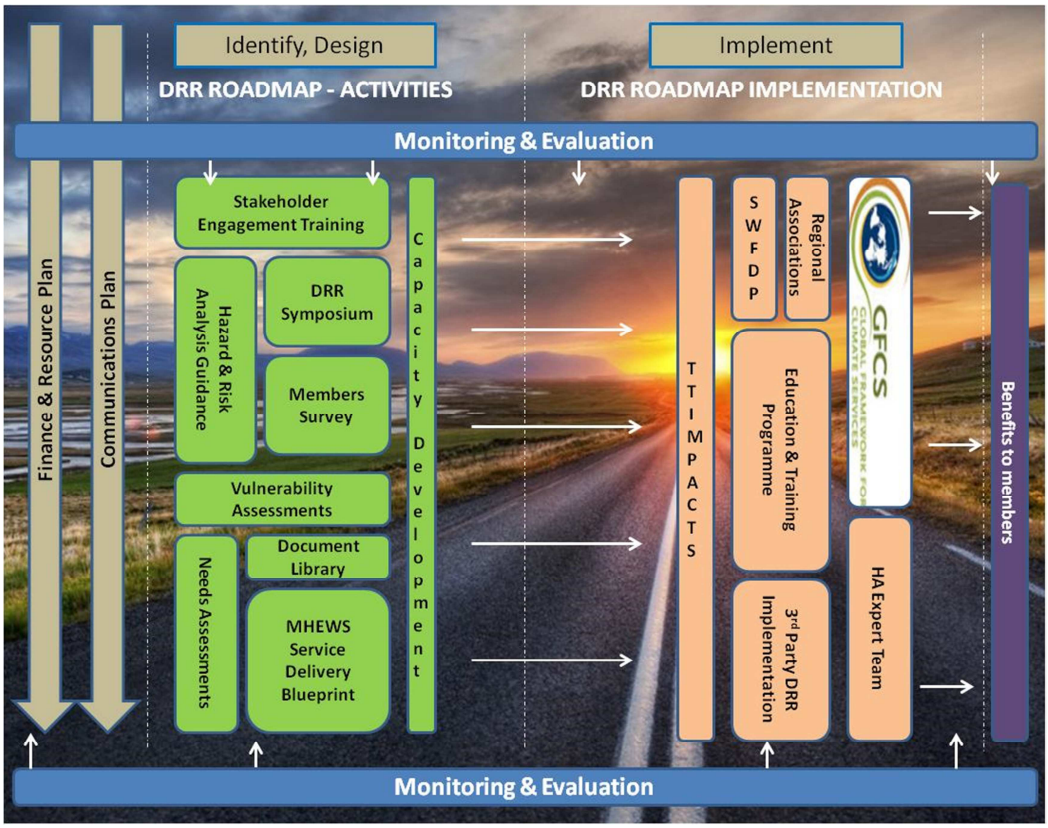

Figure 6: WMO Disaster Risk Reduction Roadmap – schematic overview

3.1 Thematic areas and activity pillars

3.1.1 Thematic areas

The implementation of the HFA has led to changes in national legal and institutional frameworks and policies on DRR, with implications on the role of and working arrangements for NMHSs. These changes provide opportunities for NMHSs such as increased recognition by their governments and

stakeholders which could result in strengthened partnerships and increased resources. However, this also means that NMHSs face increasing demand and liabilities in terms of providing products and services to a larger and more diverse group of DRR decision-makers and stakeholders. To meet these challenges, the WMO DRR Work Plan 2012-2015 highlighted the contribution of NMHSs to DRR in a number of thematic areas: **hazard and risk analysis**, **MHEWS**, **sectoral risk management** and **disaster risk financing and risk transfer mechanisms**. These thematic areas were derived from the general DRM cycle (Section 1.2) and aligned with the HFA, also expressed in the priority categories of activity for the implementation of the GFCS DRR Exemplar[29].

Each of these DRR Programme themes remains valid and adheres to a "people-centred approach" which was ratified in the Sendai Framework. However, now that this new Framework, with further implications for NMHSs and WMO, has been agreed by the international community and to add clarity, for the WMO Disaster Risk Reduction Roadmap it is proposed to explicitly link the suggested Roadmap activities to the **four priorities for action of the Sendai Framework** (Table 1) and to identify how NMHSs and WMO are already contributing to the implementation of each of these priorities – but also to DRR-related goals and priorities of other international development frameworks that have been adopted in 2015 and are expected to be adopted in 2016 (on financing development, sustainable development, climate change, humanitarian and urban issues, etc., see Section 1.3).

Table 1: Linking the Sendai Framework Priorities for Action to the thematic areas of the DRR Programme (also aligned with the GFCS DRR exemplar)

Sendai Framework Priorities for Action	Thematic areas of the DRR Programme	
	Disaster ("hot") phase	No disaster ("cold") phase
1. Understanding disaster risk	Real-time risk assessment (hazard and risk identification, analysis and evaluation)	risk assessment (hazard and risk identification, analysis and evaluation)
2. Strengthening disaster risk governance to manage disaster risk		Engagement of NMHSs and WMO in DRR governance at different levels
3. Investing in DRR for resilience	Risk reduction in sectors (sectoral risk management) Structural and non-structural measures (could be temporary prevention and mitigation)	Risk reduction in sectors (sectoral risk management) Structural and non-structural measures (prevention and mitigation) Risk transfer (disaster risk financing)
4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.	Early warning for rapid-onset hazards (impact-based) Assistance to humanitarian response	Early warning for slow-onset hazards (impact-based) Assistance to humanitarian planning

➔ **Note: the thematic area MHEWS cuts across all four priorities for action**

[29] http://www.gfcs-climate.org/sites/default/files/Priority-Areas/Disaster%20risk%20reduction/GFCS-DISASTER-RISK-REDUCTION-EXEMPLAR-FINAL-14467_en.pdf

Key questions are (based on the WMO Key Messages for the Post 2015 Framework for DRR[30]):

- **How have past/recent WMO activities contributed, and how do current/on-going ones contribute, to the four priorities for action of the Sendai Framework?**
- **Which future cross-cutting and specific WMO activities could contribute to the four priorities for action of the Sendai Framework, and how?**
- **How can WMO contribute to the achievement of goals and targets, pertaining to DRR, of other international frameworks?**

3.1.2 Activity pillars aligned with the WMO Strategy for Service Delivery

The Roadmap aims at improving the development, delivery, and uptake of meteorological, hydrological and climate services for DRR. Each thematic areas is addressed by the following activity pillars (based on the WMO DRR Work Plan 2012-2015) which largely correspond to the stages and elements of the WMO service delivery model:

- **Stakeholder and user engagement**
- **Partnerships and collaboration** (including resource mobilization) → engage users and evaluate their needs and develop partnerships
- Capacity development through **knowledge products** (e.g. guidelines, standards, training modules) → design and deliver services, link services to user needs, sustain services, develop skills and share good practices
- Capacity development through **pilot and demonstration projects** (showcasing and improving knowledge products, e.g. through training at workshops) →) → design and deliver services, link services to user needs, sustain services, develop skills and share good practices
- **Research and development** → develop and improve services

Making this a reality requires substantial development of the operational and service capacities of many NMHSs, particularly in developing and least developed countries. As one strategy for achieving this, significant efforts have been taken to engage with NMHSs / Members, RAs, TCs, scientific and technical programmes, to participate in international networks, and to establish strategic partnerships and linkages with internal and external programmes, frameworks, and events (Section 3.1.3 below).

3.1.3 Internal and external linkages and interactions

Resolution 4.2/1 (EC-66) calls for "*coherent and consistent implementation of WMO DRR priorities within all relevant programmes and projects of WMO, in the light of the recommendations of RAs and, where appropriate, the advice of the TCs*", the "*identification of the role of NMHSs … among WMO partners, United Nations bodies, and external planning processes*", and consistency "*with the WMO Strategic and Operating Plans, as well as the work plans for relevant WMO programmes and projects*" (Annex I). Recalling that the Roadmap is not a separate programme, there is a need to link to a number of internal and external mechanisms and processes that influence the DRR activities of WMO – a critical component of everything that NMHSs do Annex V.

[30] http://www.wmo.int/wcdrr/sites/default/files/2015.03.10%20-%20WMO%20Key%20Messages%20Post-2015%20Framework%20for%20DRR_0.pdf

The new WMO Strategic Plan 2016-2019 will again include DRR as one of now seven key priorities, specifically the improvement of the accuracy and effectiveness of impact-based forecasts and multi-hazard early warnings of high impact meteorological, hydrological and related environmental hazards, thereby contributing to international efforts on DRR, resilience and prevention, in particular in response to the risks associated with increased urbanization. The expected results related to this priority largely remain the same as in the current plan.

3.2 Regular consultations across WMO and with partners and respective updates of the Roadmap

Cg, EC, EC WG meetings, RA and TC sessions and management group meeting and relevant expert teams and working groups, DRR FP RA-TC-TP, DRR UI-EAGs, within the Secretariat and among key partners and users (see Section 5).

4 Priority activities (2016-2019)

As discussed earlier the activities and deliverables will be realized through existing WMO or partner frameworks, expert groups, RAs, TCs, and, in some cases, through partner organizations. Wherever possible, these activities will be structured according to:

- **Thematic areas** and **activity pillars**;
- Whether they pertain to **national and local levels**, i.e. rather to NMHSs, or **global and regional levels**, i.e. rather the WMO regional and global network and the Secretariat, and
- Whether they pertain to the **near term** or the **longer term**.

It must be noted that the activities below are suggested activities only, and for the time being rather on a global / regional level and for the first four-year period (2016-2019), which will be updated and agreed upon by WMO Members. Several activities from the DRR Work Plan 2012-2015 and the plans of other WMO entities are likely to be continued under a new Work Plan 2016-2017 (2019), i.e. the nearest term phase of this Roadmap. It will be further detailed which entity will be responsible for each activity, and how each Region (and Members or other WMO entity) may adjust the Roadmap according to their needs.

4.1 Establishment of a baseline and prioritization of activities

Underpinning all of the below will be an initial exercise to establish a solid foundation (baseline) of Member capacities, gaps, and requirements on which to move forward. This exercise may include:

- Survey of Members, RAs, TCs, other programmes and the Secretariat, identifying main activities and challenges supporting DRR on the regional, national and local levels, including a compendium of recent or current activities within WMO (e.g. PWS and DRR programmes, ETR, CCL, etc.) addressing DRR and risk assessments;
- Symposium/Conference that brings together Members, TCs, RAs, WMO Secretariat and external partners/experts to discuss the roles of WMO and NMHSs in the implementation of the Sendai Framework and to identify new priorities for the DRR Programme (based on a thorough reading of the Framework and the outcomes of the Surveys); and,
- Identify and understand complementary capabilities and requirements of non-WMO members / actors / key global, regional, national, and local partners and users such as the European Union and appropriate private sector organizations (e.g. understanding early warning requirements of key sectoral organizations such as the WHO and WFP).

Moreover, most activities will cut across all thematic areas, pillars, and also the priorities for action of the Sendai Framework, for example:

- Identification and compilation of **training initiatives** related to DRR at the national levels and potential for cross-sectoral or organizational learning activities and of opportunities for training through WMO-ETR initiatives for NMHSs, as well as for users of information (e.g. through a WMO training symposium);
- Establishment of a document library (including knowledge products such as **guidelines** and **good practices** in the thematic areas and pillars mentioned earlier, e.g. the establishment of partnerships);

- Identification of initial **pilot projects** where an additional DRR focus could deliver improved results, such as a stakeholder engagement module for the WMO Severe Weather Forecasting Demonstration Projects (SWFDP); and,
- Use of existing and identification of potential new **partnerships** to assist with the initial set of core activities.

Table 2 gives an indication of how these activities could be structured according to thematic areas and the pillars.

Table 2: Suggested structuring of priority activities according to thematic area and pillar, including examples.

	Pillar					
Thematic area	***Knowledge products (e.g. guidelines, good practices)***	***Projects (incl. trainings)***	***Stakeholder engagement***	***Research and development***	***Partnerships and networks***	***Events***
Hazard and risk assessment	WMO-CRED Atlas Event identifiers Flood Mapping Manual	Country profiles	DRR UI-EAG HRA		UNFCCC Loss and Damage IRDR INFORM	COP 21
MHEWS	Guidelines	Southeast Europe	DRR UI-EAG MHEWS	Impact-based forecasts and risk-informed warnings	"IN-MHEWS" UNEP CADRI[31]	MHEWS Conference (IC-MHEWS)
Humanitarian planning and response	Guidelines	Pilot projects	WMO Humanitarian Task Team		Coordination with GDACS[32] IASC[33]	World Humanitarian Summit
Sectoral risk management	Manuals			GAR[34] Health research	UNISDR WHO	Habitat III
Disaster risk financing	Guidelines Good practice book		DRR UI-EAG CSDRF		UNEP Finance Initiative	

In the following, an attempt has been made to place a number of activities proposed by members of the drafting team under the priorities for action of the Sendai Framework (See also the WMO Bulletin, Vol 64(2) article "Towards Substantially Reduced Disaster Risk in 2030"[35] for a more detailed assignment of WMO activities to the Sendai Framework Priorities for Action.

[31] Capacity for Disaster Reduction Initiative (CADRI), http://www.cadri.net/

[32] Global Disaster Alert and Coordination System (GDACS), http://www.gdacs.org/

[33] Inter-Agency Standing Committee (IASC) on Humanitarian Assistance, http://www.humanitarianinfo.org/iasc/pageloader.aspx

[34] UNISDR Global Assessment Reports of DRR

[35] http://www.wmo.int/bulletin/en/content/towards-substantially-reduced-disaster-risk-2030-0

4.2 Supporting priority for action 1 of the Sendai Framework: Identifiers for Cataloguing Extreme Weather, Water and Climate Events

- In collaboration with key partners, gather impact and vulnerability information related to specific sectors and hydrometeorological hazards in order to develop a hazard and risk analysis at the national and local levels.
- "Compile an overview of existing WMO guidance materials relevant to DRR and provide guidance in the development of a hydrometeorological hazard and risk analysis;
- Identify multi-partner activities, research and best practices in DRR relevant to NMHSs activities;

4.3 Supporting priority for action 2 of the Sendai Framework: Strengthen the NMHSs' role in their national disaster risk governance

- Promote the role and position of NMHSs in DRM systems, in particular the need for single voice principle in early warning[36]

4.4 Supporting priority for action 3 of the Sendai Framework: Prevention and mitigation / sectoral risk management and risk transfer

- Identify portable models for engagement of NMHSs with private sector disaster insurance organizations
- Working in partnership with external stakeholder design a generic NMHS DRR capacity assessment process to determine targeted investments e.g. in observation systems, modelling facilities, information platforms, etc.
- Monitor if DRR measures and initiatives supported by NMHSs and WMO do reduce risks and losses
- NMHS and collaborative partners to assess and monitor pilot project to respect or ensure service improvements;

4.5 Supporting priority for action 4 of the Sendai Framework: Strengthening MHEWS and disaster response

- Support the In-MHEWS initiative[37]
- Develop and implement relevant MHEWS responding to partner needs:
    - Identify a sample of WMO- and nationally-supported initiatives addressing the establishment of (multi-hazard) EWS;
    - Early notifications to be developed and coordinated within NMHSs, including specific stakeholders needs (compile best practices related to the development of collaborative efforts, e.g. in SWFDPs);
    - Identify potential needs, develop and deliver pilot project in collaboration with local or national level humanitarian agencies or other sectoral risk management organisation, with the aim to ensure collaboration and exchange of relevant weather, water and climate information to these users

[36] Proposal for a new activity

[37] Proposal for a new activity

- Use identified learning opportunities, whether from the WMO community or partners, to outreach, build capacity and awareness of populations and adopt practices with the aim of reducing the impacts of hazards
- Identify that all partners contribute to integrated information services
- Develop a MHEWS service delivery 'blueprint'

4.6 Potential future activities in the long term

- Build complementary delivery platforms with (potential) partner organizations to support the mandated role of NMHSs while at the same time providing the required level of information to global and regional humanitarian agencies;
- Establish a MHEWS research and development programme in partnership with NMHSs and academia

5 Implementation framework and approach (and coordination)

5.1 Governance, implementation and user-interface mechanisms and their roles and responsibilities

The Roadmap implementation plan will describe the implementation mechanisms, the phasing, scheduling and milestones associated with the delivery of the Roadmap. The implementation plan will also describe the roles and responsibilities of the key actors and stakeholders. As mentioned earlier, a key principle of the Roadmap is to utilize existing WMO mechanisms to leverage WMO activities and projects to realize the DRR Vision. The Roadmap will also seek to maintain and enhance existing partnerships, to establish new ones where necessary, and if appropriate forge links to external projects, programmes and initiatives.

Specifically the existing mechanisms will include:

1. **Congress**
2. **EC and the EC Working Group on DRR**
3. **RAs and their DRR-related expert teams and working groups**
4. **TCs and other WMO programmes and activities related to DRR and their DRR-related expert teams and working groups**
5. **DRR Focal Points of RAs, TCs and TPs (DRR FP RA-TC-TP)**
6. **DRR User-Interface Expert Advisory Groups (UI-EAGs) on:**
   - Hazard and Risk Assessment (HRA);
   - MHEWS;
   - Disaster Risk Financing (DRFI); and,
   - the CBS (DPFS-PWS) Task Team on the Provision of Operational Meteorological Assistance to Humanitarian Agencies (Humanitarian TT)
7. **Individual NMHSs**
8. **Implementing Partners**
9. **WMO Secretariat**
   - DRR Services Division
   - DRR-related task teams and working groups in the Secretariat

5.1.1 Congress and EC (incl. the EC Working Group on DRR)

Ultimate strategic direction of the DRR Programme is provided by Cg and EC. In consideration of the Cg-17 decisions, EC-67, through Resolution 5 (EC-67)[38], established the EC WG DRR, replacing the EC Working Group on Service Delivery (EC WG on SD) which previously served as an oversight mechanism for the DRR Programme.

5.1.2 RAs, TCs and TPs and the DRR Focal Points of RAs, TCs and TPs (DRR FP RA-TC-TP)

A number of WMO RAs and TCs with their respective programmes, as well as those technical and co-sponsored programmes that do not serve a TC, carry out activities directly relevant to DRR. Moreover, most of them have specific working groups and task teams on or related to DRR (Annex

[38] This resolution replaces Resolution 6 (EC-LXIII), which is no longer in force.

VI). Coordination among these entities could be strengthened through the DRR Programme in line with the Roadmap.

As a cross-cutting programme, the DRR Programme does not serve a single TC. Rather, EC (EC-64, EC-65) urged the presidents of the TCs (PTC) to (i) identify opportunities for concrete intra- and inter-commission collaboration, and to (ii) establish, engage actively with the DRR user-interface mechanisms to support the implementation of the DRR Work Plan 2012-2015. A network of DRR focal points of the TCs and those technical programmes that do not directly serve a TC **(DRR FP TC-TP)** was therefore established through nominations by the presidents of TCs (PTC) and relevant coordinating mechanisms of other technical programmes in 2013. Since then, progress has been underway to map the roles and relevant activities of TCs and RAs and to develop processes for their coordination in the implementation of the DRR Programme activities.

Cg-17 reconfirmed the establishment of the DRR FP TC-TP and requested to include focal points of the RAs as a mechanism to support the WMO-wide coordination of DRR activities. The PRA and PTC then nominated (or reconfirmed) respective DRR Focal Points (now DRR FP RA-TC-TP). The 2015 Meeting of the DRR FP RA-TC-TP was held on 3-5 November 2015, at the WMO headquarters in Geneva, Switzerland. The meeting was co-chaired by the two co-chairs of the DRR FP RA-TC-TP, Mr Michel Jean (DRR Focal Point of CBS) and Prof Kevin Horsburgh (DRR Focal Point of JCOMM).

5.1.3 DRR User-Interface Expert Advisory Groups (UI-EAGs)

EC-64 supported the utilization of specific user-interface mechanisms comprised of leading experts from the diverse DRR stakeholder community, including United Nations and other international agencies, academia, the private sector and the NMHSs. EC-64 endorsed the establishment of four **DRR User-Interface Expert Advisory Groups (UI-EAGs)** as coordinated platforms to:

- Guide documentation of good practices and development of user needs and requirements for products and services to support thematic areas in DRR decision making specifically:
    - Identify and prioritize user needs and requirements for weather, hydrological and climate products and services and as input to the TCs' activities pertaining to the development of related guidelines, manuals, and standards;
    - Facilitate engagement of the user community in the implementation of DRR and adaptation capacity development projects with WMO TCs, RAs and global operational network (e.g., GDPFS, GTS/WIS, WIGOS) to demonstrate utilization of such products and services in DRR decision-making;
- Support development of and provide feedback on the WMO DRR knowledge products; and,
- Support the implementation of the DRR Work Plan

EC-64 endorsed specifically the establishment of the following user-interface mechanisms:

- The UI-EAG on Climate Services for Hazard/Risk Analysis (EAG-HRA);
- The UI-EAG on Multi-Hazard Early Warning Systems (EAG-MHEWS);
- The UI-EAG on Climate Services for Disaster Risk Financing (EAG-DRF); and,

- An Inter-commission ad-hoc Task Team on Meteorological, Hydrological and Climate Services for Improved Humanitarian Planning and Response, established under CBS with CCl and CHy.

Over the past four years, many activities in these thematic areas and involving these groups took place, while the names, statuses and memberships of the groups have changed. For example, the EAG-HRA now reads as EAG on Hazard and Risk Assessment (which includes analysis). The Inter-commission ad-hoc Task Team on Meteorological, Hydrological and Climate Services for Improved Humanitarian Planning and Response has evolved into the CBS (DPFS-PWS) Task Team on the Provision of Operational Meteorological Assistance to Humanitarian Agencies. The work and membership of this Task Team, complemented by representatives from international humanitarian agencies, can be a basis for the fourth UI-EAG, namely the EAG on Humanitarian Planning and Response (EAG-HUM). Finally, the EAG-DRF changed its name for a period of time to EAG on Financial Risk Transfer (EAG-FRT), but it is suggested to keep the original acronym which would then read as EAG on Disaster Risk Financing.

5.1.4 National Meteorological and Hydrological Services (NMHSs)

NMHSs as the mandated delivery authority for meteorological, hydrological and climate services hold the key to successful implementation of DRR through effective engagement with their national DRR Platforms and increasing their own service delivery portfolio. NMHS also have the opportunity to build national partnerships and forge links to academia and research and development institutions. A number of NMHSs have dedicated DRR focal points, a mechanism that could be very helpful for implementing the Roadmap.

5.1.5 Implementing partners

The **implementing partners** are defined through the WMO external relations[49] (cooperation with external partners through agreements (IAEA, AU, CERN, etc.) – working arrangements (WHO, FAO, UNESCO, IMO, ECMWF, CMO, ICSU, ISO, etc.), consultative status (IABM, ICL, IUCN), and memorandums of understanding (IDB, ACMAD, ICL, UNESCAP, EC, IRI, UNDP, ADRC, NOAA, WFP, SPREP, UK Met Office, IFRC, TWAS, UNITAR, etc.); and cooperation without formal agreement (GWP, WWC, UNFCCC, UNCCD, etc.)).

5.1.6 WMO Secretariat

The **WMO Secretariat** will support the more strategic aspects of the Roadmap such as leading engagement with (potential) partner organizations (e.g. through Memorandums of Understanding) as appropriate and external stakeholders. Within the Secretariat a Steering Committee for Disaster Reduction was established in 2004 and several fixed-term teams and groups are established for specific tasks ensure coordination and linkages e.g. with climate activities (i.e. the UNFCCC and IPCC processes) and activities in relation to implement the post-2015 Sustainable Development Agenda

The WMO DRR Programme will be the primary implementing agent for the Roadmap and will provide a support and coordination function. At the WMO headquarters (Secretariat) the DRR Services Division under the Weather and DRR Services (WDS) Department acts as a “Secretariat” to the DRR Programme and will hence coordinate the further development of the Roadmap.

[49] http://www.wmo.int/pages/partners/index_en.html

5.2 Timeline / timeframes

It will be important to place a timeline around the activities and provide details as to how each activity will be **implemented**. The Roadmap will work with current implementation mechanisms (managed through the WMO DRR Programme) to identify existing activities which could be either modified, phased differently, or combined to produce a greater impact. The implementation framework aims to ensure that national, regional, and global level DRR issues and opportunities are addressed and that relations to the external side, e.g. interactions with governments through the Permanent Representatives with WMO, are better coordinated with United Nations country teams, and between WMO RAs and regional intergovernmental organizations, are fully included in the implementation phase.

The implementation of the Roadmap will be divided into specific building blocks grouping complementary activities. As the Roadmap will cover four inter-sessional periods of WMO, corresponding to the 15 years lifetime of the Sendai Framework and closely related global conventions with similar lifetimes as well as with WMO frameworks and strategic documents (see Section 3.1.3), some activities will span across all these periods, only over one period, and others only over a certain phase within a period. An overall timeline for the key activities and expected results will be developed. However, the timescales involved require the Roadmap to be a "living" document which will define an initial set of specific activities, key milestones and clear deadlines only for the first financial (intersessional period). Over the course of time framework conditions will change and necessitate regular updates and therefore further endorsement from the WMO decision-making bodies. Each financial period may have different phases (as detailed in two-year or four-year DRR Work Plans), e.g. from development, implementation, operation and evaluation. Priorities for the intersessional period 2016-2019 would be to establish the baseline and the development of pilot activities, e.g. as part of existing activities.

5.3 Financial and resource considerations

Based on the WMO Strategic and Operating Plans for the next financial period (2016-2019), the WMO results-based budget will identify regular resources to implement these plans and, hence, this Roadmap. Implementing this Roadmap will require routine and extra-budgetary contributions by Member governments to their NMHSs and to WMO, but also from overseas development agencies, NMHSs in developed countries development banks, stakeholder organizations and the United Nations system.

The WMO Office for Resource Mobilization and Development Partnerships (RMDP) focuses on securing development assistance for NMHSs in Member Countries in the form of financing (either direct or through the WMO Secretariat), transfer of technology and expertise, and leveraging strategic partnerships. This work is undertaken in close cooperation with the WMO Regional Offices and WMO technical programmes, as detailed in the WMO Resource Mobilization Strategy. It requires the identification of strategic donors, understanding their priorities and interests in investing in DRR projects in different regions, and their engagement in these projects from the early stages of assessments and project identifications on. Resource mobilization also includes seizing post-disaster funding opportunities such as the United Nations Flash Appeal led by the United Nations Office of Humanitarian Affairs (OCHA) and the Post Disaster Needs Assessment (PDNA) and reconstruction planning, led by the United Nations Development Programme (UNDP), the World Bank, and the European Union.

5.4 Communication and outreach

In order to achieve the objectives of the Roadmap, it will be necessary to develop adequate, up-to-date and regular information for and communication with WMO Members and external partners, stakeholders, and users. All these entities need to know that there is a framework available to develop and deliver hydrometeorological services for DRR, in line with a number of other frameworks such as the Sendai Framework and GFCS. They need to understand the benefits of such an approach and related collaboration. It is furthermore necessary to describe (in non-technical terms) what is available, and what is possible. Providers of DRR services, above all NMHSs, need to a willingness to take time to understand users' information requirements and what these users use the hydrometeorological information and products for.

The WMO DRR Programme website serves as a primary communication channel for this purpose. It will include regular updates to all WMO Members, with progress reports on the implementation of the Roadmap being sent to all PRs for comments. Relevant events, activities, documents (work plans, deliverables, etc.) as well as general information material (factsheets, DRR Programme/Roadmap flyer, posters, etc.) will be identified and / or developed and linked on this website. The website could also host an activity blog by all involved in the delivery of DRR services.

In addition, during WMO constituent body events (Congress, EC) as well as other meetings (e.g. IBCS, PTC/PRA meetings, etc.), progress briefings will be provided.

5.5 Monitoring and evaluation

Monitor if DRR measures and initiatives supported by NMHSs and WMO do reduce risks and losses

Monitoring and evaluating the progress with the Roadmap will need to be carried out at two levels:

- At the Programme level with milestones and deliverables and routine quality assurance by the DRR Services Division in line with QMS[50] standards. An assessment of regular (quarterly) progress reports with the Roadmap itself from the DRR Programme (DRR Services Division) could (or should) be provided by WMO RAs and the Internal Oversight Office (IOO).
- At the strategic level, by Cg and EC (including the EC WG DRR) and with the help of key performance indicators (KPIs) for the WMO Operating Plan.

Further bodies involved in the monitoring and evaluation of the Roadmap will therefore include the EC Working Group on Strategic and Operational Planning; the External Auditor, Financial Advisory Committee, and Audit Committee; and the Strategic Planning Office (SPO) which coordinates the continuous strategic planning process of WMO (including the development of WMO Strategic and Operating Plans, Programme Performance Monitoring and Evaluation Plan, and related reports).

Lastly, every major disaster triggered by hydrometeorological hazards – including the assistance provided by the NMHS / WMO and whether the NMHS was affected – should be systematically evaluated for continuous learning and improvement of services.

[50] WMO 2013: Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services (WMO-No 1100, (https://googledrivecom/host/0BwdvoC9AeWjUazhkNTdXRXUzOEU/wmo_1100_en.pdf)

6 Concluding remarks

The vision of WMO is to provide world leadership in expertise and international cooperation in weather, climate, hydrology and water resources and related environmental issues and thereby contribute to the safety and well-being of people throughout the world and to the economic benefit of all nations. The successful contribution of WMO, and the NMHSs of its Members in particular, to DRR, CCA and increased resilience is and will be based on coordinated and collaborative initiatives between the WMO Member, partners, and specific communities whose aim will be to reduce the risks and impacts of disasters due to meteorological, climatic, and hydrological hazards, at the regional and national levels.

A DRR vision for NMHSs, in this context, could be formulated as follows:

By working in partnership with government agencies, subject matter experts, academia, and commercial organizations, NMHSs are central to their DRM arrangements (e.g. national platforms for DRR) through the provision of advice and warnings across all timescales and from local to national levels, thereby increasing national resilience.

It is hoped that this Roadmap can guide the organization, in particular NMHSs and key partners, along the way towards this vision.

Annex

Annex I: Resolution 4.2/1 (EC-66)

WMO DISASTER RISK REDUCTION ROADMAP

THE EXECUTIVE COUNCIL,

Recalling Resolution 27 (Cg-XV): WMO Strategic Plan, in which DRR is a strategic priority area,

Noting:

(1) The significant importance of Disaster Risk Reduction (DRR) to WMO Members,

(2) WMO DRR activities are fundamentally based upon, and are in support of, the core work of NMHSs,

Noting further:

(1) The Hyogo Framework for Action (HFA) 2005-2015,

(2) The third World Conference on Disaster Risk Reduction (WCDRR-III) that is planned to be held from 14 to 18 March 2015, in Sendai, Japan, would consider for adoption the Post-2015 Framework for Disaster Risk Reduction,

Considering that focused effort should be made by WMO Members to provide expertise, in support of authoritative risk-informed decision-making, to:

(1) Further develop and implement Multi-Hazard Early Warning Systems that support readiness, response and resilience of nations and communities,

(2) Advance understanding of high-impact meteorological, hydrological and environmental events, and rapid transfer of scientific and technological knowledge to DRR decision-making,

(3) Support effective communication of warning information to stakeholders,

Emphasizing that the WMO DRR programme should facilitate efforts that promote delivery of authoritative forecast and warning information to decision support mechanisms at local, national, regional and global levels, through:

(1) Coherent and consistent implementation of WMO DRR priorities within all relevant programmes and projects of the WMO, in the light of the recommendations of the regional associations and, where appropriate, the advice of the technical commissions,

(2) Primary consideration to enhance NMHSs' capabilities to conduct their core activities,

(3) Clear identification of the role of NMHSs to deliver authoritative, and where possible, impact-based forecasts and warnings among WMO partners, UN bodies, and external planning processes, such as the Post-2015 Framework for DRR,

Requests the Secretary-General:

(1) In consultation with Members, to urgently develop a WMO DRR roadmap of prioritized and realistically achievable activities and deliverables, that are consistent with the WMO Strategic and Operating Plans, as well as the work plans for relevant WMO Programmes and projects;

(2) To present a draft WMO DRR roadmap to Cg-17 for consideration and to be reflected in the WMO Strategic and Operating Plans 2016-2019;

(3) To coordinate WMO-wide participation in the preparation and drafting of the Post-2015 Framework for DRR, in line with the development of the WMO DRR roadmap;

(4) To provide regular updates to Members on the progress of WMO DRR programme, including the WMO-wide engagement in the Post-2015 Framework for DRR and the planning of relevant events at WCDRR-III.

Annex II: Sections of the Cg-17 abridged final report relevant to the WMO DRR Roadmap

3.2.18 Congress stressed the importance of DRR training materials, which can also help strengthen national institutional arrangements. Congress noted that a significant amount of training modules have been developed by Members and Regional Training Centres (RTCs) that could be extended and elaborated through the introduction of additional materials from partners such as the World Bank and other partner United Nations agencies. Congress requested the Secretary General to arrange for a review and regular updating of these training modules and programmes and to facilitate access to these materials as a contribution to WMO's Capacity Development Strategy. Congress requested the Secretary-General to include a review of DRR-related training materials as part of the WMO DRR Roadmap implementation.

3.2.19 Noting that DRR is one of the priority areas of the GFCS and that the implementation of the DRR activities can demonstrate the value of climate services to risk-based DRR decisionmaking, Congress agreed that the UI-EAGs can contribute to the GFCS User Interface Platform (UIP), and that the deliverables of the WMO DRR Roadmap are relevant to strengthening of the UIP.

3.2.32 Congress noted Resolution 8 (EC-66) requesting the Secretary-General to "urgently develop a WMO DRR Roadmap of prioritized and realistically achievable activities and deliverables, that are consistent with the WMO Strategic and Operating Plans, as well as the work plans for relevant WMO Programmes and projects".

3.2.33 Congress emphasized that WMO DRR activities are based upon, and are in support of, the core work of NMHSs. Hence, the WMO DRR Programme should, in close collaboration with relevant technical programmes, and in particular the PWS Programme and Hydrology and Water Resources Programme (HWRP), facilitate efforts that promote delivery of authoritative forecast and warning

information to decision-making authorities at local, national, regional, and global levels as well as provide relevant hazard and risk analysis and assessment to assist DRM.

3.2.34 Congress requested the Secretary-General to leverage existing guideline documents already created by expert teams within the TCs, gather lessons learned from NMHSs and disaster management partners, and identify existing gaps within the DRR Roadmap outline, which need to be filled. This will increase efficiency and minimize duplication of effort as the DRR Roadmap and other planning evolves.

3.2.35 Congress emphasized that all DRR work should proceed in consideration of all relevant guidelines and documents created by the expert teams within TCs, as well as input provided from NMHSs' own DRR roadmaps, frameworks, and best practices.

3.2.36 Congress noted with appreciation that a draft WMO DRR Roadmap was prepared and sent to all the Members for their review and comments.

3.2.37 Congress noted that specific thematic areas to be addressed by the Roadmap should be closely interlinked with the priorities for action of the Sendai Framework for DRR 2015–2030, including the emphasis on a people-centred, multi-hazard approach to DRR underpinned by science and technology.

3.2.38 Congress noted that the Roadmap emphasizes the role NMHSs need to play across all timescales, including the provision of weather-specific early warnings with improved lead time, slower onset seasonal or climate-related information, and related hazard and risk information for planning and prevention purposes, including reducing existing risks and preventing the creation of new risks. In this context, the Roadmap:

a) References developments in capabilities such as multi-hazard and impact-based forecasting; especially in dissemination and communication of early warnings to emergency managers, the general public, and other relevant stakeholders, with emphasis to support NMHSs of most vulnerable Members, specifically LDCs and SIDs;
b) Provides a framework for WMO Members to enhance NMHSs' contributions to their national DRR efforts using in particular the possibilities of national and regional Platforms for DRR and forums, including forecasting, warning, service delivery, communication of forecasts and warnings to the public, and public education efforts;
c) Provides a mechanism to enhance WMO Members' and programmatic collaboration in respect of DRR;
d) Identifies both tactical and strategic opportunities to enhance the role of hydrometeorology and therefore NMHSs in global, regional, national, and sub-national DRR and climate change adaptation strategies;
e) Provides mechanisms for engagement with the international DRR stakeholder community, e.g. the United Nations system, regional organizations and economic groupings, the private sector, and humanitarian agencies;
f) Provides guidance and tools to NMHSs to strengthen linkages with emergency managers, decision makers in hydrometeorologically sensitive sectors, and the general public on reducing risk of weather, space weather, climate and water hazards.

3.2.39 Noting the enormous significance of the Sendai Framework for DRR 2015–2030 to the DRR priority of WMO and the need for assisting WMO Members in the effective implementation of this Framework through:

a) Developing DRR knowledge products (e.g. guidelines, standards, training modules) in thematic areas such as hazard and risk assessment, MHEWS, humanitarian planning and response, and disaster risk financing;
b) Assisting with the coordinated national and regional DRR capacity development activities and demonstration projects in these thematic areas;
c) Promoting, engaging in, and facilitating multi-stakeholder partnerships in DRR on different levels.

3.2.40 In this regard, Congress requested the Secretary-General, in consultation with Members and collaboration with technical commissions and regional associations, to develop a final draft of the WMO DRR Roadmap for consideration and approval by the 68th Executive Council. It requested Executive Council to guide its further development and implementation, including monitoring and evaluation, and updating, in line with the Sendai Framework for DRR 2015–2030 adopted by 187 countries and other relevant international development frameworks (e.g. on sustainable development, climate change, humanitarian assistance, and urban issues).

Annex III: Provisions in the Sendai Framework for Disaster Risk Reduction 2015-2030 with immediate relevance to WMO

- Promoting the collection, analysis, management and use of relevant data and practical information in line with national circumstances and making use of space and in situ information that results from maintained and strengthened in situ and remotely- sensed Earth and climate observations;
- Ensuring dissemination of reliable data in an appropriate format and accessibility of non-sensitive information, taking into account the needs of different categories of users (including social and cultural requirements, in particular, gender);
- Strengthening disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems (MHEWSs) through the strengthening of technical and scientific capacity to capitalize on and consolidate existing knowledge and through developing and applying methodologies and tools;
- Promoting and improving dialogue and cooperation among scientific and technological communities, the private sector, other relevant stakeholders and policymakers in order to facilitate a science/policy interface for effective decision-making in disaster risk management and for sharing good practices internationally;
- Strengthening disaster-resilient public and private investments in structural, non-structural and functional disaster risk prevention and reduction measures;
- Investing in, developing, maintaining and strengthening people-centred, multi-sectoral MHEWSs, including telecommunications systems for hazard monitoring and emergencies, simple and low-cost early warning equipment and facilities, and broadened release channels for warning information that is tailored to different user needs;

- Promoting the further development of and investment in effective, nationally compatible, regional multi- hazard early warning mechanisms, where relevant, contributing to the Global Framework for Climate Services (GFCS), and facilitate the sharing and exchange of information across all countries;
- Supporting relevant UN entities to strengthen and implement global mechanisms on hydrometeorological issues in order to raise awareness and improve the understanding of water-related disaster risks; and,
- Promoting international cooperation for DRR and enhanced coordination of respective strategies of UN entities and other international and regional organizations, especially in developing countries, in particular, the least developed countries, Small Island Developing States (SIDS), landlocked developing countries and African countries.

Annex IV: The seven global targets of the Sendai Framework for Disaster Risk Reduction 2015-2030

1. Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015.
2. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015 (Categories of affected people will be elaborated in the process for post Sendai work decided by the Conference).
3. Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.
4. 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.
5. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
6. Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.
7. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

Annex V: Linkages

Table 3: Key linkages of the Roadmap with internal and external strategies, plans, agreements, frameworks and events

Within WMO ("internal drivers")	• WMO Strategic Plan and WMO Operating Plan (2012-2015, 2016-2019)[51] • Strategic and operating/work plans of RAs, TCs and relevant WMO programmes (including associated/co-sponsored programmes),systems and projects and their working groups and expert teams (see Table 3) • WMO Strategy for Service Delivery and its Implementation Plan[52]

[51] https://www.wmo.int/pages/about/spla_en.html

	• WMO Quality Management Framework (WMO-QMF) / Quality Management System (QMS)[53] • WMO Capacity Development Strategy[54] • WMO Resource Mobilization Strategy[55] • Madrid Conference Statement and Action Plan[56] (adopted by the International Conference on Social and Economic Benefits of Weather-, Climate-, and Water-related Information and Services in 2007)
United Nations / international development frameworks and related events ("external drivers", examples):	• GFCS • SIDS Accelerated Modalities of Action [S.A.M.O.A.] Pathway[58] • Sendai Framework (focus) and its implementation guide - United Nations Plan of Action on DRR for Resilience[59] - Implementation guides "Words into Action" • Addis Ababa Action Agenda (AAAA) of the Third International Conference on Financing for Development[60] • Sustainable Development Goals (SDGs)[61] • Paris Agreement[62] • World Humanitarian Summit (Istanbul, Turkey, May 2016) • United Nations Conference on Housing and Sustainable Urban Development (Habitat III) (Quito, Ecuador, October 2016)
Other 3rd party DRR initiatives and MoU (UNOCHA & WMO, etc.)	• Group on Earth Observations (GEO) 2016-2025 Strategic Plan: Implementing Global Earth Observation System of Systems (GEOSS)[63]

Annex VI: WMO regional associations, technical commissions and other WMO programmes and activities with their working groups and task teams on or related to DRR and respective strategies, plans and agreements (examples based on PUB5)

Regional associations, technical commissions and other WMO programmes and activities • Working group, task team, or other entity related to DRR	**Respective strategies, plans and agreements**
RA I Africa • Working Group on Improved Weather Forecasting, Natural Disaster Reduction, Service Delivery and Communication	

[52] http://www.wmo.int/pages/prog/amp/pwsp/documents/WMO-SSD-1129_en.pdf
[53] http://www.bom.gov.au/wmo/quality_management.shtml
[54] http://www.wmo.int/pages/prog/dra/CDS.html
[55] http://www.wmo.int/pages/prog/dra/rmo.php
[56] http://www.wmo.ch/pages/themes/wmoprod/documents/madrid07_ActionPlan_web_E.pdf
[58] http://www.sids2014.org/samoapathway
[59] http://www.preventionweb.net/files/33703_actionplanweb14.06cs1.pdf
[60] http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/69/313
[61] https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals
[62] http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf
[63] https://www.earthobservations.org/geoss_wp.php

Regional associations, technical commissions and other WMO programmes and activities • Working group, task team, or other entity related to DRR	**Respective strategies, plans and agreements**
• Working Group on Climate and the Environment	
RA II Asia • Working Group on Disaster Risk Reduction and Service Delivery (WGDRS) with the Sub-group on Disaster Risk Reduction (WGDRS-DRR) and the Sub-group on Service Delivery (WGDRS-SD) [Working Group on Weather Services (WGWS), Expert Group on Public Weather Services Delivery (EG-PWS) & Working Group on Hydrological Services (WGHS), Expert Group on Public Weather Services Delivery (EG-PWS)] • Working Group on Hydrological Forecasts and Assessments (WGH)	
RA III South America • Working Group on Natural Disaster Prevention and Mitigation (?)	
RA IV North America, Central America and the Caribbean • Working Group on Natural Disaster Prevention and Mitigation (?)	
RA V South-West Pacific • Working Group on Hydrological Services (WG-HYS), Task Team on DRR – Water-related Disasters (TT-DRR-W) • Working Group on Weather Services (WG-WS) • Working Group on Climate Services (WG-CS) • Working Group on Natural Disaster Prevention and Mitigation (?)	
RA VI Europe • Working Group on Service Delivery and Partnership (WG-SDP) • Working Group on Technology Development and Implementation (WG-TDI) • Working Group on Climate and Hydrology (WG-CH) • Task Team on Regional Operating Plan (TT ROP)	
Commission for Agricultural Meteorology (CagM) • Focus Area (OPCAME) 3 - Natural hazards and Climate Variability/Change in Agriculture	
Commission for Basic Systems (CBS) • OPAG on Data-Processing and Forecasting System (OPAG-DPFS) with five relevant expert / task teams[64] • The Expert Team on Meeting User Needs in Reducing the Impacts of Hydrometeorological Hazards (CBS/OPAG-PWS	

[64] http://www.wmo.int/pages/prog/www/CBS/CBS-WorkProgramme/OPAG_DPFS_ETs.html

Regional associations, technical commissions and other WMO programmes and activities • Working group, task team, or other entity related to DRR	**Respective strategies, plans and agreements**
ET/DPM) (also referred to as the ET/DPM)[65]	
Commission for Climatology (CCl) • OPACE 2 Climate Monitoring and Assessment and its expert and task teams[66] • OPACE 3 Climate Prediction, Projection, and Delivery Mechanisms and its expert and task teams[67] • OPACE 4 User Interface for Climate Adaptation and Risk Management and its expert and task teams[68]	
Commission for Hydrology (CHy) • Open Panels of CHy Experts (OPACHE) with e.g. Theme Area 5 Water, Climate and Risk Management	
Joint WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM) • Services and Forecasting Systems Program Area (SFSPA)[69] • Expert Team on Waves and Coastal Hazards Forecasting Systems (ETWCH)	
Tropical Cyclone Programme (TPC)[70] • Tropical Cyclone Committee for the South-West Indian Ocean (RA I) • Hurricane Committee (RA IV) • Tropical Cyclone Committee for the South Pacific and South-East Indian Ocean (RA V) • ESCAP/WMO Typhoon Committee[71] • WMO/ESCAP Panel on Tropical Cyclones, Working Group on Disaster Risk Reduction[72]	• • RA IV Hurricane Operational Plan 2015 • Tropical Cyclone Operational Plan for the South Pacific and the South-East Indian Ocean 2014 • Strategic Plan, Typhoon Committee Operational Manual - Meteorological Component 2015 • Coordinated Technical Plan 2012-2015, Annual Operating Plan (AOP) 2013 for Meteorology, Hydrology and DPP/DRR, 2015 Edition of the Tropical Cyclone Operational Plan (TCP-21)

[65] http://www.wmo.int/pages/prog/amp/pwsp/pws-dpm_en.html
[66] http://www.wmo.int/pages/prog/wcp/ccl/opace/opace2-ccl16.php
[67] http://www.wmo.int/pages/prog/wcp/ccl/opace/opace3-ccl16.php
[68] http://www.wmo.int/pages/prog/wcp/ccl/opace/opace4-ccl16.php
[69] http://www.jcomm.info/index.php?option=com_content&view=article&id=22&Itemid=37
[70] http://www.wmo.int/pages/prog/www/tcp/organization.html
[71] http://www.typhooncommittee.org/
[72] http://www.ptc-wmoescap.org/

Annex VII: Acronyms (to be completed)

CCA
Cg
CIFDP
COP
DRM
DRR
EC
GDACS
GFCS
HFA
IBSC
IPCC
MDGs
NGO
NMHS
RA
SDGs
SWFDP
TC
TP
UNFCCC
UNISDR
WCDRR
WMO