WORLD METEOROLOGICAL ORGANIZATION

The Role of National Meteorological and Hydrological Services (NMHSs) in Implementation of Intended Nationally Determined Contributions (INDCs)

Analysis Report

October 2016

Contents

Acronyms

ADP Ad Hoc Working Group on the Durban Platform for Enhanced Action
AF Adaptation Fund
AI Annex I
COP Conference of the Parties to the UNFCCC
DRM Disaster risk management
DRR Disaster risk reduction
EWS Early warning system
FAO Food and Agriculture Organization of the United Nations
GCF Green Climate Fund
GDP Gross domestic product
GEF Global Environment Facility
GFCS Global Framework for Climate Services
GHG Greenhouse gas
INDC Intended nationally determined contribution
IPCC Intergovernmental Panel on Climate Change
LDC Least-developed country
LULUCF Land use, land-use change and forestry
M&E Monitoring and evaluation
MRV Measurement, reporting and verification
NAI Non-Annex I
NAMA National Appropriate Mitigation Actions
NAP National Adaptation Plan
NAPA National Adaptation Programmes of Action
NDCs Nationally determined contributions
NMHSs National Meteorological and Hydrological Services
NRC Norwegian Refugee Council
SCCF Special Climate Change Fund
SIDS Small-island developing states
UNDP United Nations Development Programme
UNFCCC United Nations Framework Convention on Climate Change
WMO World Meteorological Organization
WRI World Resource Institute

Executive Summary

Intended Nationally Determined Contributions (INDCs) are key instruments for enabling climate action under the United Nations Convention on Climate Change (UNFCCC). As such, it is essential that they benefit from scientific information on climate variability, trends and extremes and contain provisions that promote the climate services needed to support INDC implementation.

As of 4 April 2016, 161 INDCs have been submitted to the UNFCCC Secretariat, covering 189 (96%) of the Parties to the Convention. The Parties that have communicated INDCs account for approximately 99 per cent of the emissions of all Parties to the Convention. All Parties included information on their mitigation contributions. A total of 137 Parties, accounting for 83 per cent of the INDCs, also included an adaptation component.

All INDC adaptation components include information on key impacts and vulnerabilities. Parties reported on observed climate changes or projections of future changes, the most vulnerable sectors or geographical zones, high-risk impacts and incurred costs associated with extreme events. In terms of climate hazards, the main sources of concern identified by most Parties are flooding, sea level rise and drought or desertification.

In total, 66 Parties out of 189 (35%) have used climate services terminology in their INDCs. Sub-Saharan Africa invoked climate services the most, followed by Latin America and the Caribbean. This indicates the degree to which developing countries are concerned with the use of climate services.

Priority areas and sectors identified in the adaptation component of the communicated INDCs include water, agriculture, health, ecosystems, infrastructure, forestry, energy, disaster risk reduction, food security, coastal protection, and fisheries. These areas include all Global Framework for Climate Services (GFCS) priority areas and align with the implementation plan.

The INDCs show the increasing interest of Parties in enhanced cooperation to achieve climate change goals collectively through a multilateral response, and to raise ambition in the future. In particular, Parties stressed the need for strengthening finance, technology transfer and capacity-building support for climate action as a means of creating an enabling environment and scaling up action. This Policy Brief is intended to facilitate understanding concerning the role of NMHSs in implementation of INDCs at national level. NMHSs are encouraged to access the INDCs submitted by their governments and explore the sectors and areas of competency to which they can actively contribute during implementation.

1. INTRODUCTION

The INDCs were requested under the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP), during COP19. The ADP asked all Parties to submit the protocol they will follow in order to comply with the objective of the UN Framework Convention on Climate Change (UNFCCC) before COP 21, to be used as the basis for the negotiations led to the Paris Agreement[1].

Under the Paris Agreement, at COP 21, INDCs were replaced by Nationally Determined Contributions (NDCs). Under Article 4 (para. 2), the Paris Agreement states: “Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.” As of 4 April 2016, 161 INDCs

[1] Paris Agreement. FCCC/CP/L.9/Rev.1.UNFCCC Secretariat. 2015. Available at: http://unfccc.int/meetings/paris_nov_2015/items/9445.php

have been submitted, covering 189 Parties to the Convention, representing 96 per cent of Parties to the Convention.

1.1 Purpose

The objective of this report is to demonstrate the role of National Meteorological and Hydrological Services (NMHSs) in contributing and implementing INDCs along with other governmental sectors at national level. It includes an analysis of the INDCs and NDCs submitted by Parties to the UNFCCC. In particular, it identifies the role of climate services in INDC/NDC implementation.

Climate services provide science-based and user-specific information relating to past, present and potential future climate for decision-support in sectors affected by climate at global, regional and local scales. They connect natural science and socioeconomic research with practice. They help society cope with climate variability and change through the transformation of climate related data – together with other relevant information – into customized products such as projections, trends, economic analysis and services to user communities in different sectors. Such services involve high-quality data and derivatives (e.g., prediction, products, advisories, etc.) from national and international databases on temperature, rainfall, wind, soil moisture and ocean conditions, as well as maps, risk and vulnerability analyses, assessments, and long-term projections and scenarios. Depending on specific needs, these data and information products may be combined with non-meteorological data, such as agricultural production, health trends, population distributions in high-risk areas, road and infrastructure maps for the delivery of goods, and other socio-economic variables. For example, the provision of more and better climate services will allow farmers to fine-tune their planting and marketing strategies, based on seasonal climate forecasts; empower disaster-risk managers to prepare more effectively for droughts and heavy precipitation; assist public health services to target vaccine and other prevention campaigns to limit climate-related disease outbreaks such as malaria and meningitis; and help improve the management of water resources. These activities all contribute to appropriate adaptation planning in a changing climate (GFCS, 2016).

1.2 Methodology

Taking into account that INDCs are very heterogeneous, and that the information is very condensed, each INDC was studied using a keyword search in English, French and Spanish to explore if countries mentioned “climate services for the implementation of their INDCs[2]. The analysis was divided by developed countries, economies in transition and developing countries, giving special importance to developing countries as they are the countries who put the most emphasis on climate services” (Figure 1).

[2] Keywords were: “monitoring”, “forecast”, “services”, “data” and “projections”.

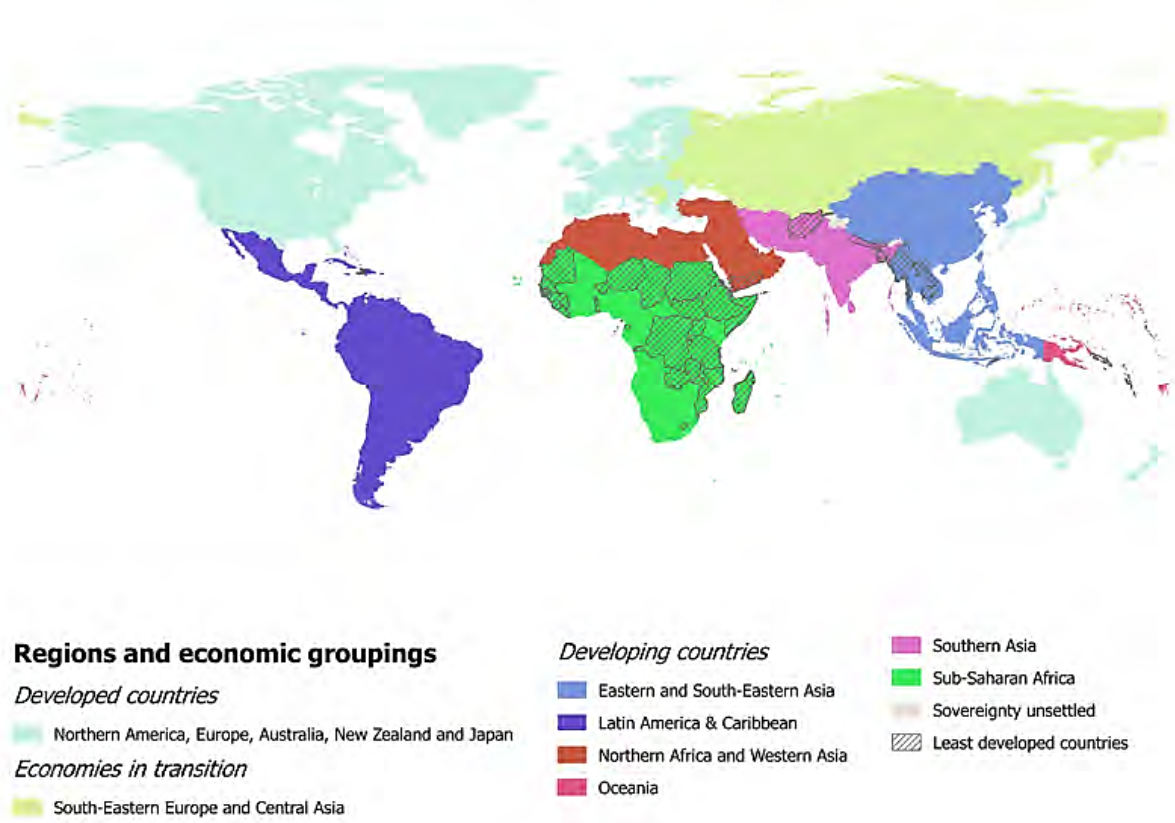

Figure 1. The Agriculture sectors in the Intended Nationally Determined Contributions by Food and Agriculture Organization of the United Nations. 2016. (FAO, 2016)

2. GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

The World Climate Conference-3, held in Geneva in 2009, decided to establish the GFCS. GFCS is a UN-led initiative spearheaded by the World Meteorological Organization (WMO) to guide the development and application of science-based climate information and services in support of decision-making in climate-sensitive sectors.

2.1 Pillars of the Global Framework for Climate Services

GFCS is being designed around five major components or "pillars":

- User Interface Platform (users can make their voices heard through the Platform and make sure climate services are relevant to their needs)
- Climate Services Information System (the production and distribution system for climate data and information products that address user needs)
- Observations and Monitoring (the essential infrastructure for generating the necessary climate data)
- Research, Modelling and Prediction (to advance the science needed for improved climate services that meet user needs)
- Capacity Development (to support the systematic development of the institutions, infrastructure and human resources needed for effective climate services)

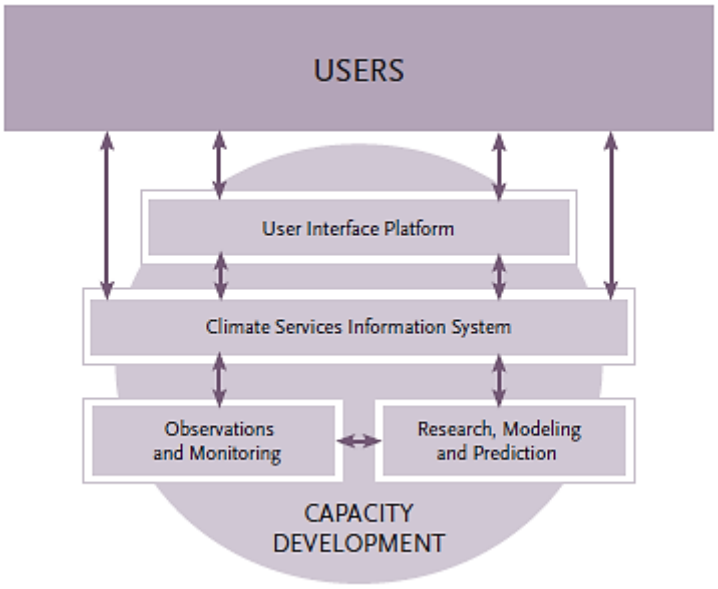

Figure 2. Schematic illustration of the GFCS pillars (WMO, 2014)

Capacity development component encompasses the other components. Arrows depict flows of information and feedback. The concepts underlying this diagram are especially applicable at national and subnational or local levels.

As Figure 2 shows, these five pillars are interconnected and they need to interact with each other in order to make the production, delivery and application of climate services fully effective. In scaling and scoping the GFCS to a particular country it will be essential to identify institutional structures and programmes that are already delivering climate services or have the potential to contribute to their delivery, and where needs are not being met to develop plans and proposals for filling the gaps. (WMO, 2012, p. 4)

2.2 Priority Areas of the Global Framework for Climate Services

The GFCS focuses especially on five major priority areas that are:

- Agriculture and food security: Food security is a major issue in an era of rapid population growth. Agriculture is vulnerable not only to market fluctuations but also to climate variability and climate change and natural hazards. However, climate services can improve the agriculture sector.
- Disaster Risk Reduction (DRR): Most natural hazards are caused by weather and climate. Climate services can help countries and communities build greater resilience against floods, droughts, storms and other hydrometeorological hazards.
- Energy: Energy systems are the engine of economic and social development. Energy generation and planning of operations are markedly affected by meteorological events and energy systems are increasingly exposed to the vagaries of weather and climate affecting both the availability and energy demand. Climate services are especially important in this sector.
- Health: Climate variability and climate change have important repercussions on public health. Temperature and rainfall conditions influence the spread of communicable diseases while extreme weather events cause injury and death. Demand-driven climate services can empower the health community to save lives.
- Water: Water is vital for life, but an over or under supply can threaten life, societies and economies. The amount and availability of water is strongly influenced by climate variability and change. Seasonal climate outlooks and

other climate services and products can greatly improve water supply management.[3]

3. OVERVIEW OF THE INTENDED NATIONALLY DETERMINED CONTRIBUTIONS (INDCs)

The Conference of Parties (COP), by its decision 1/CP.19, invited all Parties to initiate or intensify domestic preparations for their INDCs towards achieving the objective of the Convention as set out in its Article 2, without prejudice to the legal nature of the contributions, in the context of adopting a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties. The Paris Agreement clarifies that NDCs should be communicated by Parties every five years and they will be published in a public registry, having a specific format and informing about the progression and reflecting the Party's ambitions to comply with the UNFCCC's objective to reduce emissions.[4]

Article 2 of the Paris Agreement describes the need to hold the global temperature rise since pre-industrial times well below 2ºC, with a preference to limit it to 1.5 degrees. With the submission of NDCs, countries are required to provide national plans to comply with this objective. Furthermore, the Paris Agreement also establishes the need to adapt to the impacts of climate change.

In addition, article 6 (para. 8) of Paris Agreement states, that NDCs implementation plans shall enhance public and private sector participation and shall enable opportunities for coordination across instruments and relevant institutional arrangements. Moreover, the Paris Agreement stresses the relevance of cooperation in reaching its goals, developed country Parties should support financially developing country Parties with respect to both mitigation and adaptation. Parties shall also promote technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions. Finally, capacity-building is very important for developing and least developed countries in order to help them take effective climate change action.

Indeed, NDCs are a key instrument to bring about climate action and adapt to climate change in different sectors such as decarbonizing energy supply through shifts to renewable energy, energy efficiency improvements, better land management, urban planning and transport. Climate services are essential for preparing and implementing NDCs.

3.1 Mitigation

Mitigation includes reducing greenhouse gas (GHG) emissions and enhancing sinks and reservoirs. The Convention requires the Parties to formulate and implement programmes to mitigate climate change, to develop and update national inventories of GHG emissions and removals, to promote and cooperate in the development, application and diffusion of climate friendly technologies, and to adopt national policies and measures to limit GHG emissions and protect and enhance sinks and reservoirs.[5]

Mitigation commitments may be in the form of "actions", policies and projects. They can also be presented in form of outcomes as reduction of GHG emissions to a specific level (GHG outcome) or an increase in renewable energy to a specific level (a non-GHG outcome) (WRI, 2015).

Within INDCs, all but three countries include energy under their climate change mitigation contributions (targets and/or actions) (FAO, 2016, p.3).

[3] http://www.wmo.int/gfcs/priority-areas
[4] Article 4.9 of the Paris Agreement.
[5] UNFCCC website. Accessed on the 04/07/16 http://unfccc.int/focus/mitigation/items/7169.php

3.2 Adaptation

Adaptation consists of the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. Climate Services are key on those areas. (IPCC, 2014, p. 5)

Countries need to adapt to the impacts of climate change, and even though they are not obliged to including adaptation within their INDCs, they are invited to do so. The main adaptation planning mentioned within INDCs is the National Adaptation Plan (NAP). (WRI, 2015). The NAP was established by the UNFCCC to facilitate adaptation planning in Least Developed Countries (LDCs) and developing countries. By 2 April 2016, 137 Parties, including 46 LDC Parties, had included an adaptation component in their INDCs. The UNFCCC secretariat received adaptation components from 54 African States, 42 Asia-Pacific States, 30 Latin American and Caribbean States, 7 Eastern European States and 2 Western European and other States (figure 3). Some of them indicated that adaptation is their main priority in addressing climate change.

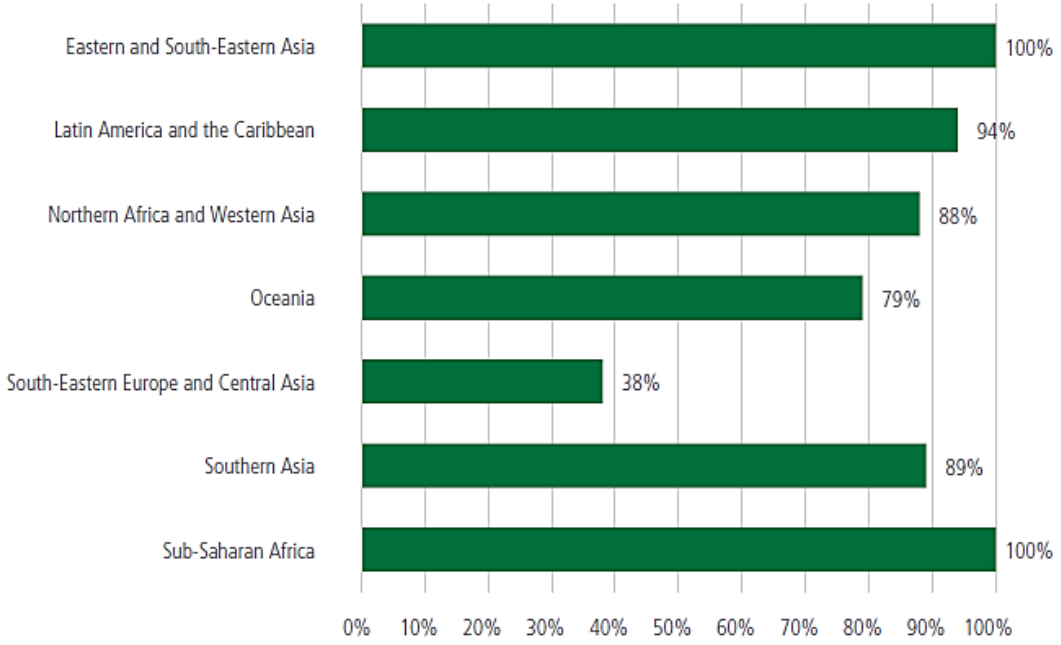

Figure 3: Percentage of countries that include an adaptation section, by region (FAO, 2016)

Many Parties have highlighted; increased extreme weather, in particular floods and drought; changes, mostly negative, in rainfall patterns; and increased water scarcity (figure 4). The timely provision of climate services to the user communities in different sectors and at different levels can support climate change adaptation to address these issues. Climate data, science, information and knowledge are critical components that can facilitate the activities identified under the four key elements (A. Lay the groundwork and address gaps; B. Preparatory elements; C. Implementation strategies and; D. Reporting, monitoring and review) that need to be undertaken in the development of NAPs.

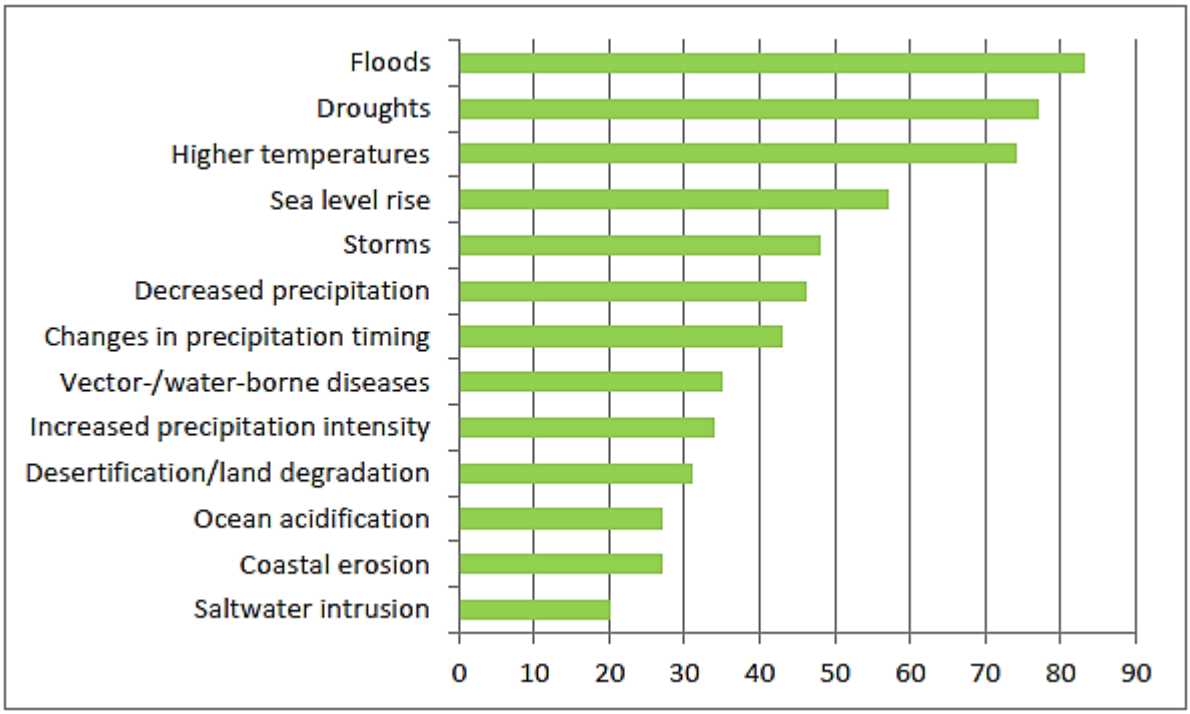

Figure 4: *Key climate-related hazards identified in the adaptation component of the communicated INDCs (UNFCCC, 2016)*

WMO and the NMHSs of its Members have a vast reservoir of expertise, service capabilities, data and tools that can be delivered through governments, programmes, technical commissions, expert teams and partner organizations. GFCS, the UN-led initiative spearheaded by WMO to guide the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors, can provide effective support to the NAP process. The GFCS provides tools for addressing needs in many of the most widely prioritized sectors identified in the INDCs (figure 5).

In the context of climate change adaptation, NMHSs are critical actors in national development planning within almost all sectors, as they serve as major custodians and providers of data and competencies required to support climate change research and climate services which underpin adaptation at national level. Key services include provision of information and scientific advice on climate variability, trends and change (including at the policy level). NMHSs are encouraged to continue their active role in the UNFCCC Least Developed Expert Group (LEG) process and to provide technical advice to LDCs for preparing and implementing NAPs and other contributions to the LDC work programme. NAPs are expected to guide the allocation of significant climate finance in the future. (WMO, 2016, p. 45).

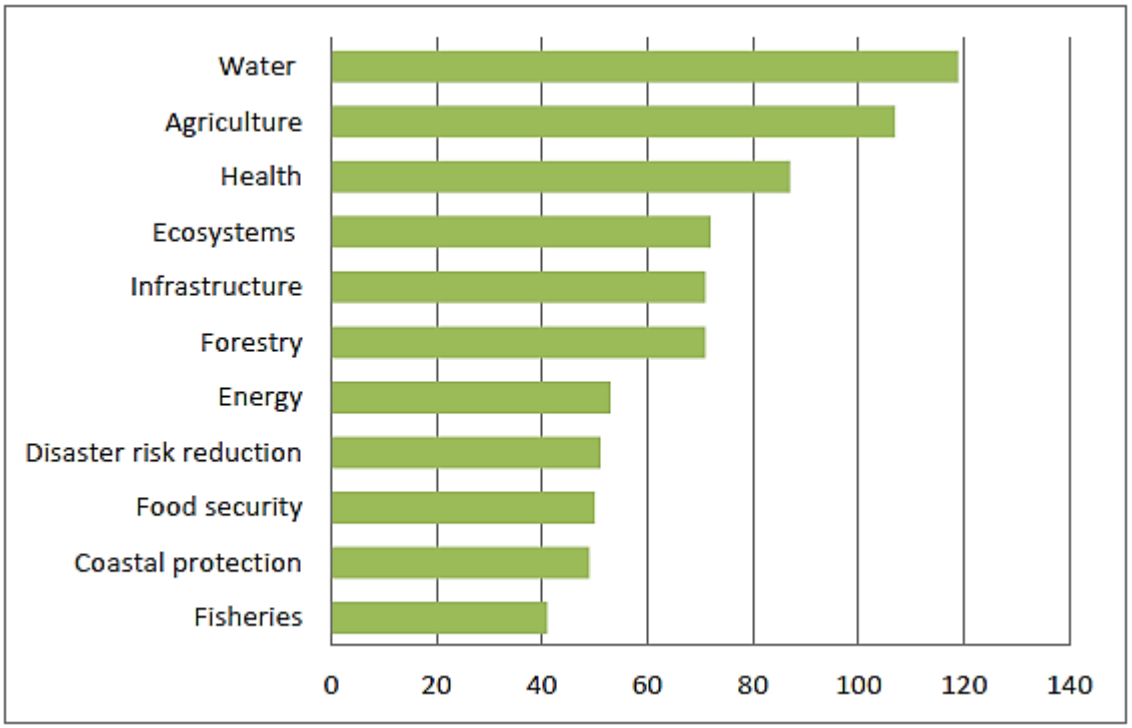

Figure 5: Priority areas and sectors for adaptation actions identified in the adaptation component of the communicated INDCs (UNFCCC, 2016)

4. ROLE OF NMHSS IN PROVISION OF CLIMATE SERVICES FOR PREPARATION AND IMPLEMENTATION OF NDCs

4.1 The role of NMHSs

The WMO Convention reaffirms the vital importance of the mission of NMHSs in observing and understanding weather and climate and in providing meteorological, hydrological and related services in support of relevant national needs, which should include:

a) Protection of life and property;
b) Safeguarding the environment;
c) Contributing to sustainable development;
d) Promoting long-term observation and collection of meteorological, hydrological and
e) climatological data, including related environmental data;
f) Promotion of endogenous capacity-building;
g) Meeting international commitments; and
h) Contributing to international cooperation. (WMO, 2012)

Nowadays, 191 NMHSs, in various degrees, are involved with climate services thanks to many years of research, investment, coordination, collaboration and effort. Over time, knowledge about the weather has improved and the use of weather forecasts has evolved into a daily life routine, where an increasing number of decisions are dependent on them. As climate is the accumulation over time of weather conditions and climate information is generated, based on similar models that require similar inputs, climate services are naturally – and strongly – rooted in the existing capabilities for the provision of weather services (WMO, 2016, p. 15).

As has been the case since the beginning of the modern era of societal and environmental management, knowledge of weather and hydrological and climate processes is key to all aspects of human endeavour as observed from their influence on cultures, traditions and development paths of societies. It is within this framework that various NMHSs have been well positioned to monitor, forecast and issue warnings on a

wide range of weather-, climate- and water-related events that affect human life and socioeconomic development (WMO, 2015).

Beyond the year 2015, the new agreement under UNFCCC adopted in Paris in December 2015 will have a significant influence on the demands from NMHSs for user-oriented weather, hydrological, climate and related environmental services to meet the evolving needs of governments, partners and other decision-makers to achieve sustainable development. The efforts of NMHSs contribute to enhancing the safety and well-being of society, ending poverty, sustaining development and economic growth, improving access to clean drinking water, enhancing food production, achieving good health outcomes, mitigating and adapting to climate change, exploiting renewable energy sources and increasing the prosperity of their populations. (WMO, 2016, p. 15)

4.2 Provision of Climate Services by Sectors in the INDCs

NMHSs are the official authoritative source and – in most countries – the single source for weather and climate data and the single voice on weather warnings in their respective countries. In many, they are also responsible for climate, hydrology, air quality, seismic and tsunami warnings and space weather.

All around the world, NMHSs design, operate and maintain the national observing systems; handle data management, including quality analysis and quality control (QA/QC); develop and maintain data archives; undertake climate monitoring; provide the oversight on climate standards; carry out climate diagnostics, climate analysis and climate assessment; disseminate climate products based on the data via a variety of media; and participate in regional climate outlook forums and some interaction with users, to meet requests and gather feedback.

Partnerships between NMHSs and academia, other government departments, international and non-governmental organizations and, where appropriate and possible, the private sector and civil society, help society make better decisions based on more complete and accurate weather, water and climate information. These partnerships provide better data coverage and information processing, higher-resolution models and more precise and useful specialized products for societal benefits, including opportunities to better support government and other decision-makers regarding safety, the economy and security. NMHSs work with these partnerships to develop appropriate national frameworks that facilitate the gathering and sharing of data and expertise to make the information easy to access in real time, in useful forms and at low cost. Climate services provided by NMHSs within the framework of WMO in the different GFCS Priority Areas are described below with appropriate reference to the elements of the NAP process. (WMO, 2016, p. 16)

As explained previously, the GFCS focuses on five main priority areas. Climate services are specifically mentioned in 66 out of 189 INDCs, most frequently in the INDCs of LDCs and developing countries.

Sub-Saharan Africa is the region that mentions climate services the most followed by Latin America and the Caribbean. This shows how developing countries are concerned with the use of climate services although it is not the majority of them, we may observe a growing interest.

Water, agriculture and health in that order are the sectors in which climate services are in greatest demand.

4.2.1 Agriculture

Agriculture is inherently sensitive to climate conditions and is among the sectors most vulnerable to weather and climate risks. Figure 5 shows how it is the second sector where climate services are more commonly required (28.8% of climate services are addressed to the agriculture sector). Despite impressive advances in agricultural

technology over the last half a century, climate variability has a significant influence on agriculture, which is heavily dependent on rainfall, sunshine and temperature. Progress continues in the fight against hunger, yet an unacceptably large number of people still lack the food they need for an active and healthy life. The latest available estimates indicate that about 795 million people in the world – just over one in nine – were undernourished (IFAD, FAO, & WFO, 2015). Of the total annual crop losses in world agriculture, many are due to direct weather and climatic effects, such as droughts, flash floods, untimely rains, frost, hail and severe storms (Hay, 2007). The number of hydrometeorological hazards in particular (such as droughts, floods, tropical storms and wildfires), which were measured on an average of 195 per year in 1987 and 1998 increased to 365 per year from 2000 to 2008 (WMO, 2014 (c), p. 70). Human-induced climate change has introduced a new, complicating factor into the food security equation: modifying natural climate variability.

Moreover, agriculture and food security in the 21st century face multiple challenges. Extreme weather, climate variability and long-term climate change pose important challenges to future agriculture and food security. Climate-related disasters, such as droughts and floods, can lead to crop failure, food insecurity, destruction of key livelihood assets, mass migration of people and negative national economic growth (WMO, 2014 (a), p. 35). Adverse weather and climate conditions directly affect agricultural productivity, livelihoods, water security, land use, agricultural marketing systems, market instability, food prices, trade, and economic policies. Small-holder farmers, fishers, livestock herders and forest-dependent communities are often highly vulnerable to these impacts. A recent FAO study (FAO, 2015) highlighted that between 2003 and 2013, economic impacts of climate-related disasters on agricultural sectors in developing countries accounted for about 25 % of the total recorded damage and loss. Climate change is expected to affect all the components that influence food security: availability, access, stability and utilization.

Many Parties referred to actions in the agriculture sector and emphasized the importance of integrating adaptation into agriculture and food production and ensuring food security and sustainability of agriculture. Parties have introduced various programmes and policies, such as promoting sustainable agriculture and land and resource management, implementing integrated adaptation programmes for agriculture, developing climate criteria for agricultural programmes and adapting agricultural calendars. Others described specific agricultural methods for combating climate-related problems. For example, Parties described methods for pest management, including integrated pest management, introduction of heat-, drought- and disease-resistant crops, fodder types and livestock breeds and the distribution of medicine and vet services. Many referred to the importance of more diversified and resilient crops and livestock, for example by promoting native maize species and other improved crop varieties. Parties also referred to key agricultural improvements, such as enhanced irrigation systems, drought management and methods to reduce erosion. Other measures mentioned include affordable insurance, climate research, use of information and traditional knowledge and early warning systems. Tailored products in these areas have already been developed or can be, to meet these identified needs.

Climate services in agriculture can help develop sustainable and economically viable agricultural systems, improve production and quality, reduce losses and risks, decrease costs, increase efficiency in the use of water, labour and energy, conserve natural resources and decrease pollution by agricultural chemicals or other agents that contribute to the degradation of the environment (WMO, 2014 (a)). Climate services are critical for strengthening the information and early warning systems on food and agriculture.

In this context, NMHSs can provide weather and climate information to the agricultural sectors (agriculture, livestock, fishery and forestry) that can be particularly helpful to anticipate, prepare for, and respond to, agriculture or food-security risks, on both short timescales to address problems triggered by climate extremes (droughts, floods, thermal extremes) and longer-term risks associated with climate change (increasing

temperature, loss of biodiversity, land and forest degradation, salinization and desertification). NMHS databases which are currently available increase climate knowledge and improve prediction capabilities, facilitating agricultural and food-security decision-making from international policy level to local operational farm management strategies. Through the analysis of long-term climatic data and use of current weather observations, NMHSs provide agrometeorological advisories and services to the agricultural sectors on a regular basis during the cropping season. These enable farmers, herders and fishers to make appropriate operational decisions on their livelihoods for efficient management of natural resources and to improve agricultural productivity (WMO, 2016).

4.2.2 Disaster Risk Reduction (DRR)

DRR was addressed concomitantly to adaptation by several Parties and they reported on their current and future efforts relating to DRR, in particular against storms, floods, sea level rise and glacial lake outburst floods. Many provided information on their national and regional DRR strategies, policies, plans, platforms and frameworks. Specific measures highlighted by Parties include early warning systems, risk management institutions, hazard maps, building codes and other standards, infrastructure protection measures and contingency plans. Some Parties are developing insurance schemes, in particular to protect the most vulnerable communities and to incentivize climate-proof construction. A few Parties intend to resettle part of their population highly exposed to climate risk in safer areas. In this context, one Party announced that it is preparing its people for emigration owing to its high vulnerability to sea level rise.

Almost 75 percent of countries prioritize Disaster Risk Management (DRM) in their INDCs (figure 6). DRM is an adaptation priority in all regions, particularly in Southern Asia (100 percent), Eastern and South-Eastern Asia (92 percent), and Oceania (82 percent). Countries in these regions place a particular emphasis on DRR in this context. 10 countries note national plans and strategies on DRM or DRR.

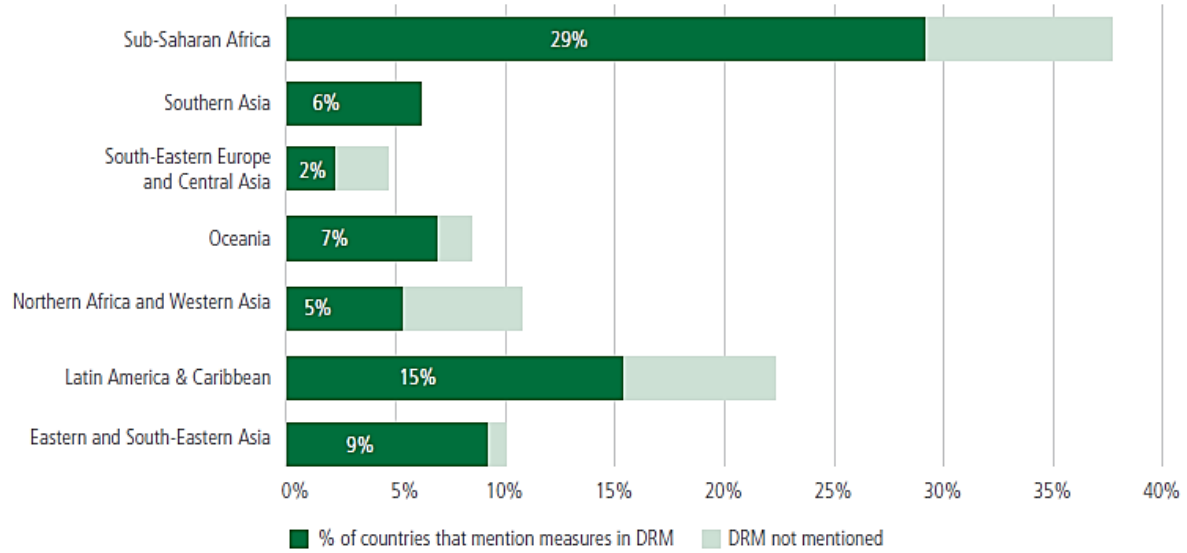

Figure 6: Percentage of countries that refer to DRM, by region (FAO, 2016)

About 60 percent of countries included specific policies and actions related to DRM in their INDCs that largely fall under the following categories in line with the Sendai Framework for Disaster Risk Reduction[6]:

1. Understanding disaster risk (e.g. collection, analysis, management and use of data, capacity building at all stakeholder levels, hazard mapping, food security and vulnerability assessments).

[6] Sendai Framework for Disaster Risk Reduction 2015

2. Strengthening disaster risk governance to manage disaster risk (e.g. development and implementation of DRR strategies and plans; mainstreaming DRR; raising public awareness).
3. Investing in disaster risk reduction for resilience (e.g. structural and non-structural measures in DRR, insurance mechanisms).
4. Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction (e.g. contingency plans, early warning systems (EWS), forecasting, hazard-monitoring). (FAO, 2016)

Natural hazards involving weather, climate and water are a major source of death, injury and physical destruction. Natural hazards become natural disasters when people's lives and livelihoods are destroyed. Natural hazards cause significant loss of life every year. They cause human and material losses that erode gains in economic development and are a major obstacle to sustainable development. Nine in 10 of the most commonly reported disasters are directly or indirectly related to weather or climate. During the past five decades, disasters of hydrometeorological origin, such as droughts, floods, storms, tropical cyclones and wildfires, have caused major losses of human lives and livelihoods and the destruction of economic and social infrastructure, as well as environmental damage.

Likewise, natural hazards occur across different space- and time scales and each is unique in some way. Tornadoes and flash floods are short-lived violent events that affect relatively small areas. Other hazards, such as droughts, develop slowly but can affect large areas of a continent and entire populations of smaller countries for months or even years. In temperate latitudes, protracted periods of hot weather (heatwaves) in summer can lead to severe heat stress in vulnerable populations. An extreme weather event can involve multiple hazards at the same time or in quick succession. In addition to high winds and heavy rain, a tropical storm can result in flooding and mudslides. (WMO, 2016, pp. 25-26)

4.2.3 Health

Human health was commonly cited as a priority sector. A number of Parties are aiming to achieve: an overall integration of climate impacts and/or the identification of priority actions in the health sector; an enhanced understanding of climate–health connections and changing disease patterns; and enhanced management systems or contingency plans for public health to improve the adaptive capacity of public medical services. In terms of more specific measures to combat vector-borne diseases, Parties referred to, for example, protecting pregnant women and children under five against vector-borne diseases, suppressing mosquito populations and distributing test kits for vector-borne diseases. Other measures include early warning systems with epidemiological information, health surveillance programmes and contingency plans in the event of heatwaves.

Health professionals need observational data from NMHSs in order to establish national and subnational level causal linkages between climate conditions and health outcomes. This first order assessment will then inform the further utility of using climate information and services to manage health risks. When strong associations are observed or known, NMHSs provide near-real-time monitoring data of local conditions: for example, air quality can directly inform population advisories or combined data of precipitation, soil moisture and surface air temperature conditions can be used to monitor daily-to-weekly suitability of vector-borne disease transmission (WMO, 2016).

NMHSs can support health actions through the provision of weather and climate data (WMO, Disaster Risk Reduction Exemplar to the User Interface Platform of the Global Framework for Climate Services, 2014), such as:

1. Data collection and access: specific measures may be needed as part of the adaptation strategy to improve (i) the availability of historical and future

hazard data, metadata, tools and methodologies in hazard identification, monitoring, and mapping; but also (ii) availability of health exposure, impact, and vulnerability information, and user-capacity to incorporate climate information in routine health decisions;
2. Integrated data management: health surveillance is analogous to systems for meteorological observations. Integrated data-management systems to analyse and monitor social indicators from health surveillance alongside climate and environmental observations. Examples, standards, and tools for integrated data management should be sought;
3. Research and risk assessments: these require integrated data to link historical climate data and observations, with qualitative and quantitative health vulnerability and exposure information. (WMO, 2016)

4.2.4 Water

Water management (both surface- and groundwater) is intrinsically linked to climate variability and change. Climate data are critical for the assessment of fluctuations and trends and the risks arising from exposure and vulnerability to natural hazards (floods and droughts) and for the sustainable management of the water resources. There is a wide cross-section of users from the water sector, including, for example, hydrological characterization, water supply, flood management and control, irrigation and drainage, power generation, fisheries and conservation, navigation and recreation. These users need a range of climate services (WMO, 2014 (d)) to support decisions necessary for integrated water resource management (IWRM) planning, which include:

1. Identification of extreme weather and climate hazards that pose water-related risks;
2. Identification of populations vulnerable to weather and climate hazards, including those in the coastal zone;
3. Allocation and re-allocation of water resources;
4. Design and placement of infrastructure and personnel (water-management organizations, structures and facilities);
5. Implementation of risk management and emergency preparedness practices and Procedures.

Referring to Figure 5, it shows that water is one of the highest priority area.

NMHSs can provide a wide range of data in different formats – point or distributed data, instantaneous or averaged – over different periods of time, to serve a number of purposes for water management. Many meteorological and hydrological models are now designed to produce probabilistic output for risk analysis, so the interfacing of climate data feeds with predictive water models is a complex matter. There are frequent gaps and mismatches between the nature and distribution of climate observing systems and those networks devised for water monitoring (WMO, 2014 (d)).

4.2.5 Energy

Energy, as a priority area and sector for adaptation, has been identified in more than 50% of submitted INDCs (Figure 5). Climate services have a very broad role in adaptation to climate change within the energy sector. Even more important is the role climate services will need to play in the convention of energy systems to renewable sources, which will be essential for achieving the Paris Agreement's mitigation goal. Renewables, such as wind, solar and hydropower, are highly sensitive to climate.

Energy is essential to almost all aspects of human welfare, including access to water, agricultural productivity, healthcare, education, job creation and environmental sustainability (UNDP, 2005).

Renewable energy was highlighted in several INDCs. Related actions are aimed at increasing the share of, and improving, access to clean energy, such as feed-in tariffs,

investment programmes for renewable energy generation and the improvement of the grid infrastructure to make it fit for renewable energy sources. Several Parties communicated quantified renewable energy targets, with some aiming to achieve 100% renewable energy supply.

Actions to achieve energy efficiency, highlighted in several INDCs, include: energy efficiency standards; the modernization of energy generation and transmission infrastructure; the promotion of smart grids; efficiency improvements in industrial processes and the building sector; and energy conservation standards.

Climate-related information relevant to mapping of renewable resources (wind and solar), energy operations, demand estimation (heating and cooling), and design standards can contribute substantially towards achieving these objectives.

Energy generation and planning of operations are markedly affected by meteorological events and energy systems are increasingly exposed to the vagaries of weather and climate affecting both availability and energy demand. By taking into account weather and climate information, energy systems can therefore considerably improve their resilience to weather extremes and climate variability and change, as well as their full chain of operations during their entire life cycle. Energy is essential for the functioning of the four GFCS Priority Areas (Agriculture and food security, Water, Health and DRR) while, at the same time, energy efficiency and generation of renewable energy are sensitive to weather, climate and water. Through appropriate partnerships and stakeholder engagement, the application of weather and climate information can provide useful support to energy-management decisions and relevant policy making to achieve optimal balancing of supply and demand, as well as to drive behavioral changes in energy saving (WMO, 2016, p. 42).

5. PLANNING AND MEANS OF IMPLEMENTATION OF NDCS

5.1 Planning and implementation process

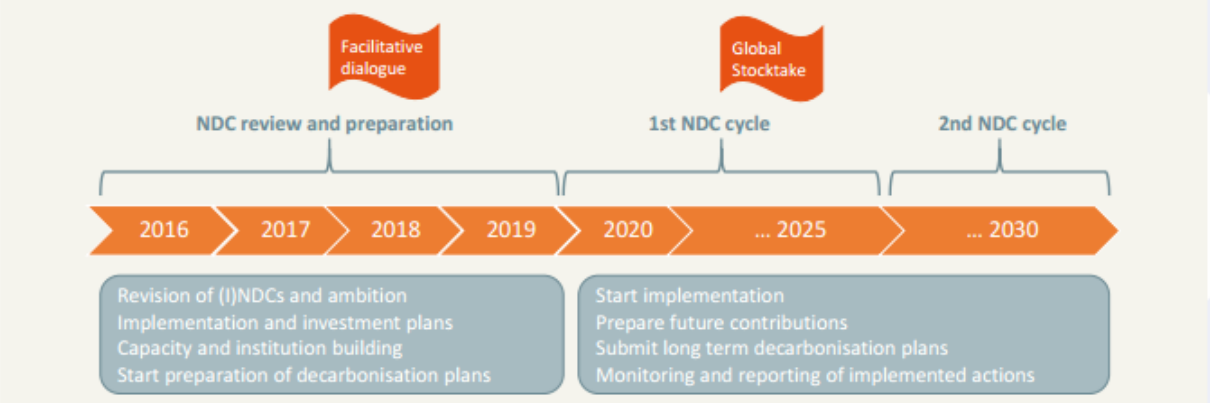

Figure 1: Schematic timeline for INDC process and activities

In the first phase - from 2016 to 2020 - the focus will be on the preparation of implementation plans and associated resource and investment plans. In addition to the formal ratification of the Agreement, countries will also need to review their current INDCs to increase the level of ambition. This is expected to start immediately and certainly with a view to having a clearer understanding of individual country's increased mitigation ambition in time for the Facilitative Dialogue on INDC progress as well as the publication of the IPCC Special Report on pathways for 1.5°C in 2018. Capacity and institution building will be important in this phase to allow for the proper planning, implementation and monitoring of NDC related activities.

In 2020 the Paris Agreement enters into force and the implementation of the NDCs formally starts, although the implementation of mitigation activities, in particular those in advanced planning stages, is likely to begin immediately. From 2020 countries are expected to prepare and present future contributions alongside long term decarbonisation plans. At the latest, countries will need to present their new NDCs in 2020 with intended targets and contributions to 2025/20230 and in 2025 for targets to 2035. Monitoring of the implementation of mitigation actions will feed into the Global Stocktakes to be undertaken in 2023 and 2028 to assess progress towards achieving the global climate goal.

Figure 7: (I)NDC-NDC timeline from 2016 to 2030 (New Climate Institute, March 2016)

Most Parties provided information in their INDCs on the means of implementation, including finance, technology and capacity-building needed to support the implementation of their envisaged actions (Figure 7).

Specific support needs identified by Parties include:

1. Favorable enabling environments with appropriate institutional arrangements and legislation, including for mainstreaming climate change in development planning, gender mainstreaming and strengthening the engagement of subnational communities and the private sector;
2. Sufficient financial resources to assess, plan, implement, monitor and evaluate adaptation actions;
3. Technologies for adaptation, including in the areas of climate observation and monitoring, early warning systems, water resources management, including irrigation and wastewater management, coastal zones, resilient transportation systems, sustainable or climate-smart agriculture, forestry (including forest fires) and land management;
4. Training and building of institutional and human capacities and technical expertise, including in the area of vulnerability and adaptation assessments, cost–benefit analysis and the development of sectoral finance plans;
5. Research, data and information, including in the areas of climate forecasting and modelling, satellite data, regionally downscaled climate data and research into international energy markets;
6. Education, raising awareness and outreach on climate change impacts and adaptation. (UNFCCC, 2016, p. 62)

5.2 Financial Mechanisms

Within INDCs, countries expressed (to different degrees) the support needed to implement their contributions. And, almost 30 percent of the countries included estimates of their financial needs. Box 6 exhibits the share of countries that specify or intend to seek international financial support. However, they did not specify largely in what specific sectors they should be helped out.

Table 1

Countries indicating need for financial support for the implementation of their INDCs

	TOTAL PARTIES	% OF PARTIES HIGHLIGHTING NEED FOR FINANCIAL SUPPORT
Least developed countries	47	100%
Developing countries	84	92%
Countries in transition	16	55%

Source: "The agriculture sectors in the INDCs: Analysis" by Food and Agriculture Organization of the United Nations (FAO), 2016

The UNFCCC foresees a financial assistance from Annex II Parties (Developed countries) to less developed countries (Non-Annex) in implementing the Convention. To facilitate this, the Convention established a Financial Mechanism to provide funds to developing country Parties.

The Financial Mechanism is formed by the Global Environment Facility (GEF), the Green Climate Fund (GCF), and four special funds: the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF), both managed by the GEF, and the GCF under the Convention; and the Adaptation Fund (AF) under the Kyoto Protocol.

Since 1991, the GEF has become an international partnership of 183 countries, international institutions, civil society organizations, and private sector to address global

environmental issues. The Green Climate Fund (GCF) goal is to provide a global response to climate change. It allocates its resources to low-emission and climate-resilient projects and programmes in developing countries. The Fund pays particular attention to the needs of societies that are highly vulnerable to the effects of climate change, in particular Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African States. WMO is the first UN Agency to formalize relationship with the Fund in June 2016. The WMO priority areas within the GCF will be:

- Transforming energy generation and access
- Creating climate-smart cities
- Encouraging low-emission and climate-resilient agriculture
- Enhancing resilience in Small Island Developing States (SIDS)[7]

The SCCF, operated by the GEF, was established under the Convention in 2001 to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification. The LDCF was established to address the special needs of the Least Developed Countries (LDCs) under the Climate Convention. Specifically, the LDCF was tasked with financing the preparation and implementation of National Adaptation Programs of Action (NAPAs), which use existing information to identify a country's priorities for adaptation actions.

The Adaptation Fund (AF) was established in 2001 to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.

The Paris Agreement states in Article 9 that developed countries should financially assist developing countries, in particular the least developed countries and small island developing States, to help them comply with the Convention's objective. Also, developed countries should be taking the lead at mobilizing climate financing. Cooperation among Annex I and non-Annex countries is also seen as essential to mitigate and adapt to climate change.

6. CONCLUSIONS

Within the Paris Agreement, NDCs are key instruments to pursue the Convention's objective and to address climate change. Within NDCs[8], adaptation and mitigation are the main tools to achieve the Paris Agreement's goal. NMHSs are of great importance, especially in developing or less developed countries to implement the adaptation and mitigation plans. Climate Services help, within the capacity building and the implementation process, to strengthen the response particularly of developing and least developed countries to climate change. For instance, NMHSs may provide warning systems, identify severe weather events related to climate change valuable in sectors such as health, water, energy and agriculture. WMO has become the first United Nations agency to formalize its relationship with the Green Climate Fund (GCF). By signing its accreditation master agreement with GCF, WMO can now receive financial resources for GCF projects. This development represents an important milestone for both GCF and the United Nations system, signaling the role of the Fund in supporting international organizations to advance low-emission, climate-resilient development and adaptation. There is an urgent need to build the scientific and operational capability of institutions around the world to underpin the information and service needs of policymakers and

[7] WMO, "WMO first UN agency to formalize relationship with Green Climate Fund" Press Release Number: 6-2016
http://public.wmo.int/en/media/press-release/wmo-first-un-agency-formalize-relationship-green-climate-fund

[8] By its decision 17CP.21, paragraph 22, the Conference of the Parties (COP) invited Parties to communicate their first NDC no later than when the Party submits its respective instrument of ratification, acceptance, approval or accession of the Paris Agreement. In the same paragraph, the COP further stated that if a Party has communicated an INDC prior to joining the Agreement, that Party shall be considered to have satisfied the provision of decision 1/CP.21, paragraph 22, unless that Party decides otherwise.

vulnerable communities. WMO is already working with its Members to prepare GCF submissions along these lines. NMHSs are encouraged to contact the GCF Nationally Designated Authorities in their countries to explore the use of the GCF for promoting climate services. While NDCs may have served as a catalyst for the consolidation and enhancement of climate-related policies in a few countries, in many it has represented an incentive to initiate them (UNFCCC, 2016). In general, it can be argued that closer cooperation among governmental and non-governmental stakeholders at national level related to preparation of the INDCs provide stronger grounds for increased action in the future.

7. REFERENCES

FAO (United Nations Food and Agricultural Organization), 2015. *The impact of disasters on agriculture and food security.* Rome: FAO.

NRC, 2016. *The Agriculture Sectors in the Intended Nationally Determined Contributions: Analysis.* Rome: Climate and Environment Division (NRC) Publications.

GFCS (Global Framework for Climate Services), 2016. *Review of the White Paper on the Contribution of the GFCS to the 2030 Agenda.* Geneva: Secretariat.

Hay, J. 2007. *Extreme weather and climate events, and farming risks.* Berlin: Sivakumar and R. Motha.

Hellmuth, et. al. 2011. *A Better Climate for disaster Risk Management.* New York: Columbia University.

IFAD, FAO, & WFO, 2015. *The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress.* Rome: FAO.

IPCC (Intergovernmental Panel on Climate Change), 2014. *Climate Change 2014: Impacts, Adaptation and Vulnerability, Summary for Policymakers (*Working Group II contribution to the fifth assessment report of the intergovernmental panel on climate change). Cambridge: Cambridge University Press.

IPCC 2014 *Climate Change 2007: Working Group III: Mitigation of Climate Change.* Cambridge: Cambridge University Press.

NCI (New Climate Institute), March 2016

UNDP (United Nations Development Programme), 2005. *Energizing the Millenium Development Goals: A Guide to Energy's Role in Reducing Poverty.* New York: UNDP.

UNFCCC (United Nations Framework Convention on Climate Change), 2016. *Aggregate effect of the intended nationally determined contributions: an update.* FCCC/CP/2016/2

GFCS, 2012. *Guidelines on Frameworks for Climate Services at the National Level.* Geneva.

GFCS, 2014 (a). *Agriculture and Food Security Exemplar to the User Interface Platform of the Global Framework for Climate Services.* Geneva: WMO.

GFCS, 2014 (b). *Disaster Risk Reduction Exemplar to the User Interface Platform of the Global Framework for Climate Services.* Geneva: WMO.

GFCS, 2014 (c). *Implementation Plan of the Global Framework for Climate Services.* Geneva: WMO.

GFCS, 2014 (d). *Water Exemplar to the User Interface Platform of the Global Framework for Climate Services.* Geneva: WMO.

WMO, 2011. *Climate knowledge for action: A Global Framework for Climate Services –empowering the most.* Geneva: High-Level Taskforce for the Global Framework for Climate Services.

WMO, 2015. *The role and operation of National Meteorological and Hydrological Services: A statement by the World Meteorological Organization for decision-makers.* Geneva.

WMO, GFCS, 2016. *Climate Services for Supporting Climate Change Adaptation: Supplement to the Technical Guidelines for the National Adaptation Plan Process.* Geneva.

WRI (World Resources Institute), 2015. *Decoding Intended Nationally Determined Contributions (INDCS): A Guide for Understanding Country Commitments.*