TECHNICAL ADVISORY SERVICES FOR THE PREPARATION OF GCF COUNTRY PROGRAMMES

Technical Assistance to North Macedonia

DELIVERABLE 3: REPORT ON CAPACITY ASSESSMENT OF CLIMATE INFORMATION SERVICES IN NORTH MACEDONIA

Prepared for:

GCF

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ACRONYMS

AMS	Automatic meteorological stations
BUR	Biennial Update Report
CIS	Climate Information Services
CMC	Crisis Management Centre
DRR	Disaster Risk Reduction
EWS	Early Warning System
FAO	Food and Agriculture Organisation
GCF	Green Climate Fund
GFCS	Global Framework for Climate Services
MAFWE	Ministry of Agriculture, Forestry and Water Economy
MoEPP	Ministry of Environment and Physical Planning
MoU	Memorandum of Understanding
NDA	National Designated Authority
NEA	National Extension Agency
NFCS	National Framework on Climate Services
NMHS	National Hydro Meteorological Service
UNFCCC	United Nations Framework Convention on Climate Change
WBG	World Bank Group
WMO	World Meteorological Organisation

EXECUTIVE SUMMARY

The ability to make better decisions through climate information services (CIS) leads to the generation of more value for a number of economic sectors such as the agricultural, energy, water, forestry sectors among others. The purpose of this capacity assessment is to gain an in-depth understanding of the state of the art of the CIS in North Macedonia, identify the knowledge and information gaps and propose recommendations on how to address these gaps. The process of developing this report involved:

- Stakeholder Mapping
- Conducting Self-Assessment Survey (via a survey for a wide group of stakeholders – including feedback from 13 stakeholders)
- Analysis of collected information and development of the Report and Recommendations

Regarding the Institutional Dimension of Climate Information Services, the Consultant rates the overall categorization as between "essential capacity" and "full capacity". The legislative framework is clear and based on feedback received, the NHMS is operating at a high level with regards to institutional coordination with key ministries, the Crisis Management Centre, and international partners. Improvement may be possible in cooperation with academic / research institutions within North Macedonia and formalization / automatization of some relationships with some of the relevant departments the Ministry of Agriculture, Forestry, and Water Economy as well as with the main energy company and/or Energy Agency.

Regarding the Technical Dimension of Climate Information Services, the Consultant rates the overall categorization as between "basic capacity" and "essential capacity". Based on feedback received, the NHMS is operating at a level between a basic and essential with regards to technical capacity. Improvement is necessary regarding equipment, systems for agrometeorological stations (covering the agricultural land, producing data, analysing the data and delivering on-line services to the end users). It would also be value added to more fully automate information / data sharing with, for example, the National Extension Agency, the energy sector and perhaps other stakeholders (e.g. publicly funded academia).

Regarding the Service Dimension of Climate Information Services, the Consultant rates the overall categorization as "essential capacity". Based on feedback received, the NHMS is operating at the level of essential capacity with regards to the service dimension. Improvement is necessary regarding staffing – especially regarding training and looking towards engaging younger professionals within the organization.

Specific recommendations stemming from the report are as follows:

Identify resources for improved climate observation and processing / flow of information. Approximate sums of necessary financial resources for establishment and maintenance of Climate services information system have been developed by the NHMS and are included in Annex 1 – amounting to approximately 850,000 EUR. The Consultant notes that this sum may not be sufficient, and the budget with specific activities should be further developed to account for various improvements mentioned in this report. This could be mobilized as part of GCF support (or other

donor support) with cofinancing from the Government. Additional budgetary resources may also be necessary for the re-mobilization of occasional observers.

Develop institutional coordination and ongoing information sharing with new actors including, for example, some departments within MAFWE (Rural Development Department, Phytosanitary Department), ESM, the NEA, and potentially with academia. For ESM in particular, this could involve a fee for service approach. Developing these systems will likely take significant technical assistance. This technical assistance could be mobilised for example as part of any GCF project (either in adaptation or mitigation) or from the EU's IPA Funds. The Consultant believes it would be useful to re-start the practice of dissemination of the raw data in digital format to various stakeholders.

Further automate information sharing: This could include publishing more information (databases) to the climate change website (www.klimatskipromeni.mk) or other web-based platforms. Automated weather forecast data sharing will be particularly useful for day-ahead and hour-ahead electricity trading markets in the energy sector (for estimating PV and wind production). This activity is also important for services for the agricultural sector e.g. evaporation which is crucial for irrigation scheduling, max, and min, temperatures, forecasting of frost, hail, drought, or heat waves.

Further develop younger professionals and the overall team: This is partly linked to budget availability and partly linked to training and educational programmes – wherein newer staff needs to be up-skilled to fully take over new responsibilities while existing staff can continue to build their skills.

Formalize a feedback mechanism: It would be useful to have a formal feedback mechanism (perhaps annually) to understand more fully the needs of climate information users, whether the NHMS is fulfilling those needs, and where there may be opportunities for enhanced impact.

The main recommendation regarding the users of climate information services is to **build off of this report to more fully crystallize a programme of operations / action plan for enhancing climate information services**. This could include more involvement of academia or other actors (such as the NEA) in generating climate information and / or processing this information for useful activities. After the process of building capacities (technical and staff-wise), the NHMS can then be officially mandated to produce more tailored products which to be defined in cooperation with the key stakeholders. These activities would need to be financially supported by the Government and / or on a commercial basis where appropriate.

1. OVERVIEW INTRODUCTION

1.1. BACKGROUND

The ability to make better decisions through climate information services (CIS) leads to the generation of more value for a number of economic sectors such as the agricultural, energy, water, forestry sectors among others. It is estimated that improved weather, climate, water observations and forecasting could lead to up to USD 30 billion per year in increased global productivity and up to USD 2 billion per year in reduced asset losses. The benefit-cost ratios are estimated to be in the order of 10 to 1 and in some cases even higher[1].

The capacity assessment will be based on the framework for assessment of capacities adopted by the GFCS and will focus on the following key questions:

- What specific components can the National Hydro-meteorological Service provide at present?
- What are the gaps and opportunities for improvement?
- What other institutions play a relevant role in the provision of meteorological and hydrological services?
- Who are the main users of the climate services?
- What do the users need from the climate services to maximize investments and address vulnerabilities?

1.2. SCOPE AND OBJECTIVE

The purpose of this capacity assessment is to gain an in-depth understanding of the state of the art of the CIS in North Macedonia, identify the knowledge and information gaps and propose recommendations on how to address these gaps. Specifically, the assessment will:

- Identify the gaps in the quality, accessibility and availability of current CIS in the country;
- Understand the users' needs for CIS in different sectors (e.g. agriculture, water, energy);
- Map the climate information services system and institutional partnerships at local and national level and the needs for effective co-production and delivery of climate information services;
- Assess key bottlenecks and intervention points within the overall system, including where and how technology is inhibiting the analysis, communication, uptake and use of such information.
- Identify key intervention points to enhance the production, uptake, use and impacts of CIS in the country

[1] World Meteorological Organization (WMO), World Bank Group (WBG), Global Facility for Disaster Reduction and Recovery (GFDRR), United States Agency for International Development (USAID), 2015. Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services (WMO-No. 1153).

1.3.METHODOLOGY

The capacity assessment consisted of the six tasks described below (Figure 1).

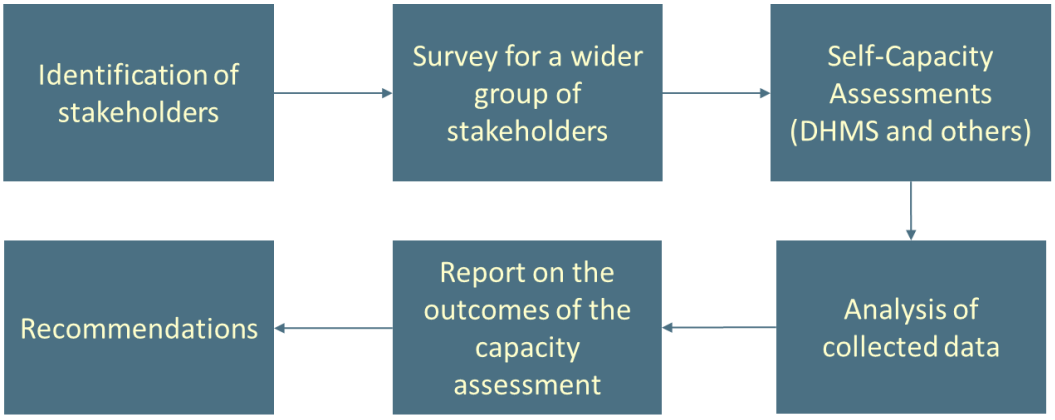


Figure 1: Methodology for performing capacity assessment on CIS

Task 1. Perform Stakeholder Mapping

The main audience for this capacity assessment is national stakeholders with a role in the chain for CIS, linking climate knowledge to action at the national level. This includes National Meteorological and Hydrological Services (NMHSs) and technical sector experts, partners of NMHSs, across different climate-vulnerable sectors (e.g. agriculture, civil protection, health, water resource management, energy, etc.[2]) that are involved in the process of generating, tailoring and/or using climate information. Other stakeholders to engage include research institutes and private sector. Questions to identify the key stakeholders include the following:

Hydro-meteorological Service

Agricultural sector

Water sector

Energy sector

- Who are the key stakeholders already mandated to provide climate information and/ or climate services to vulnerable communities?
- Who is making use of the climate information, and whose task could be improved with climate information?
- Who has a potential interest in utilizing climate information and capacity to contribute to it?

[2] Note that the forestry sector was not covered as an appropriate respondent was not identified by the MAFWE in this department.

The list of stakeholders was confirmed in conversations with the National Designated Authority (NDA) of North Macedonia – who also conducted the initial outreach to the relevant stakeholders. A list of the stakeholders providing feedback is included in the table below. In total, information was received from 10 stakeholder organisations in written form.

Table 1: List of stakeholders providing feedback on the climate information services

Institution	Name of individual	Department
Provider Institution: National Hydro Meteorological Service (NMHS)	Ms. Nina Aleksovska	Department of Meteorology, Head of Department
	Mr. Aleksandar Karanfilovski	Department of Meteorological Data
	Ms. Suzana Alcinovska Monevska	International Adviser to the PR, Head of Division for Climatology and Climate Change
	Ms. Silvana Stevkova	Department of Agrometeorology
	Mr. Vasko Stojov	Department of Hydrology
Ministry of Agriculture, Forestry and Water Economy	Bojan Durnev	Department of Water
	Nadica Dzerkovska	Phytosanitary Department
	Neda Gruevska	Agriculture Department
	Lidija Cadikovska	Dept. for International Cooperation
Agency for Promotion of Agricultural Development (Extension services) (NEA)	Elgafar Jusufi	Extension services
	Petar Andonov	Independent Officer for Rural Development
	Zlatko Sireta	Assistant Head of Agriculture and Rural Development
Ss. Cyril and Methodius University in Skopje - Faculty of Agricultural Science and Food	Prof. Zoran Dimov	Faculty of Agricultural Sciences and Food
Ss. Cyril and Methodius University in Skopje - Faculty of Forestry	Prof. Nikola Nikolov	Faculty of Forestry

Institution	Name of individual	Department
Faculty of Natural Science, Dept. of physics	Mr Ivica Milevski	
Ministry of Economy	Ms. Valentina Stardelova	Head of Energy Department
	Mr. Ismail Luma	State Advisor for Energy
	Ms. Bojana Stojcevska	Junior Assistant at the Energy Department
Energy Producer - publicly owned (ESM)	Mr. Igor Ilijovski	Senior Engineer for Development of New Energy Sources
	Mr Blagoj Gajdardzhiski	Director of Development and Investments
Energy Agency of the Republic of North Macedonia	Mr. Nehri Emrula	Director
Republic of North Macedonia Crisis Management Center	Mr. Agron Budzaku	Director
Ministry of Environment and Physical Planning	Ms. Teodora Obradović Grnčarovska	National Climate Change Focal Point and MRV Unit
	Mr. Ylber Mirta	Head of Water Department

Task 2. Conduct Self-Assessment Survey

An online self-assessment survey was prepared on the based on the guidelines of Global Framework for Climate Services (GFCS) (2020): *Capacity Development for Climate Services: Guidelines for National Meteorological and Hydrological Services*.[3] The objective of the survey was to self-assess the extent to which the NMHS can deliver services. The self-assessment survey focused on the capacity to:

- access and process observational data
- manage and analyse climate data
- convert the data into relevant and usable information and products, and
- contribute to the development of a range of products in support of decision-making.

[3] GFCS, 2020. *Capacity Development for Climate Services: Guidelines for National Meteorological and Hydrological Services*. Available here: https://library.wmo.int/doc_num.php?explnum_id=10272

This also involved collecting additional information to complement the outcomes from the self-assessment survey via in-depth questionnaires from key stakeholders. The identification of the key stakeholders was based on their function in the value chain of the CIS in order to achieve a representation from each important aspect of the CIS. The in-depth questionnaires were prepared based on the GFCS in support of capacity assessments activities. The questionnaires were shared with the key stakeholders / information users by the NDA and follow-up conversations were held to explain the content of the questions. Initially, it was thought that the Consultant would carry out interviews but most stakeholders found it more appropriate to provide written responses. A list of the organisations from whom feedback was received is in the table above.

Task 3. Analysis of collected information and development of the Report on the outcomes of the capacity assessment – including recommendations

This final report includes the results from the assessment and a concise summary of the key capacity gaps for CIS and provide recommendations on how to convert those gaps into a potential agenda for capacity development. The report can be shared with the stakeholders for feedback and validation.

1.4. STRUCTURE OF THE REPORT

Section 1 of this report describes its purpose and methodology.

Section 2 of this report describes more in-depth what is meant by Climate Information Services.

Section 3 of this report outlines the feedback received from stakeholders / information producers and users.

Section 4 outlines conclusions of the report and recommendations – including for the Government of North Macedonia and potentially to actions to be integrated into GCF programmes.

2. CLIMATE INFORMATION SERVICES

2.1. OVERVIEW

Climate Information Services (CIS) involve the production, translation, transfer, and use of climate information for decision-making on climate change actions.[4] CIS rely on collaboration of multiple stakeholders and institutions at the national level, working together in a coordinated national value chain for climate information, linking knowledge to action. They support decision-making if they are tailored to decision-makers' needs and are relevant to the decision-making context.

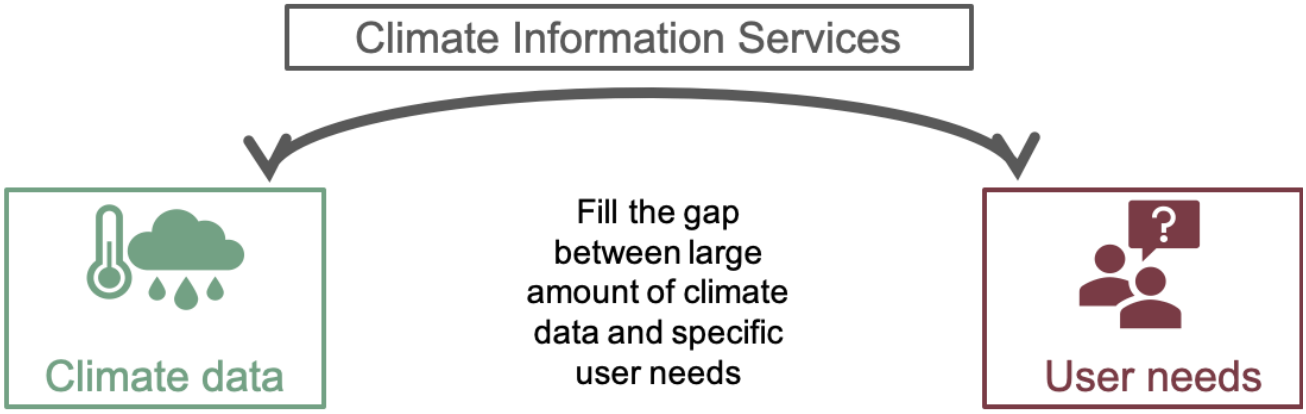


Figure 2. Climate Information Services

To ensure that climate information services are adequate, scientifically-sound and reliable, a Global Framework for Climate Services (GFCS) (https://gfcs.wmo.int/) was set up in 2009 at the World Climate Conference 3. The Framework's goal is to enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of science- based climate information and prediction into planning, policy and practice on the global, regional and national scale. The GFCS provides the basis for evaluating:

- **Accessibility:** the level of access that different stakeholders have of climate information;
- **Capacity:** the level of capacity of stakeholders in a country to produce, transfer and use climate information;
- **Data:** the current availability and quality of climate observations and impact data;
- **Partnership:** mechanisms to enhance interactions between climate service users and providers;

[4] C. Vaughan, S. Dessai (2014). **Climate services for society: Origins, institutional arrangements, and design elements for an evaluation framework**. Wiley Interdiscip. Rev. Clim. Change 5, pp. 587-603, 10.1002/wcc.290

- **Quality:** the extent to which climate services integrate advances in climate and applications sciences, and the spatial and temporal resolution, reliability and accuracy of information.

CIS are important to inform national and sectoral policies and strategies (e.g. Nationally Determined Contributions, National Adaptation Plan) and achieve low-carbon and climate resilient economic development in North Macedonia. Additionally, CIS are critical to develop a solid climate rationale for climate change projects and design effective adaptation and mitigation investments. The definitions of some key terms are provided in Box 1 below. Box 2 describes some additional detail about the GFCS.

Box 1: Definitions used within the capacity assessment

Climate data: Historical and real-time climate observations along with direct model outputs covering historical and future periods. Information about how these observations and model outputs were generated (metadata) should accompany all climate data.

Climate information: Climate data, climate products and/ or climate knowledge.

Climate product: A derived synthesis of climate data that combines climate data with climate knowledge to add value.

Climate information service: A service providing climate information in a way that assists decision-making by individuals and organizations. It requires appropriate engagement along with an effective access mechanism and must respond to user needs.

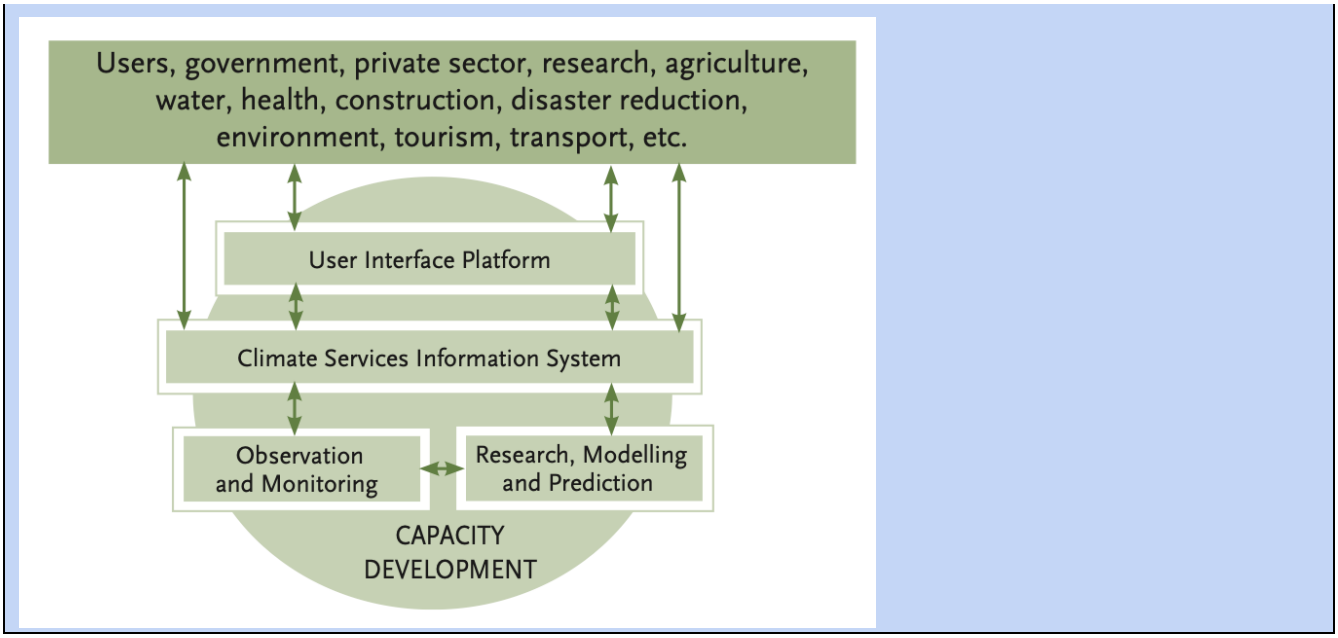
Source: Global Framework for Climate Services (WMO, 2011).

Box 2. Global Framework for Climate Services (GFCS)

The Global Framework for Climate Services (GFCS) was established in recognition of the need for interaction amongst hydrometeorological and non-hydrometeorological stakeholders in order to complete the value chain for climate services. It seeks "to enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of science-based climate information and prediction into planning, policy and practice on the global, regional and national scale."

As the GFCS aims to develop technically and scientifically sound capacity to apply and generate climate information and products at national, regional and global levels, capacity development is central to climate service development. In fact, the Capacity Development component of the GFCS implementation plan can be seen as the foundation that links and supports the four other pillars of the GFCS. The full scope of all these pillars is described in the GFCS implementation plan (WMO, 2014*a*).[5] The diagram below shows how capacity development encompasses and supports all other pillars.

[5] Available at https://library.wmo.int/index.php?lvl=notice_display&id=20047.



2.2. CAPACITY CATEGORIES

The state of the CIS can be analysed based on three fundamental dimensions (WMO, 2014) as described in the table below.

Dimension	Description
Institutional dimension	The ***institutional dimension*** refers the cooperation of relevant stakeholders which are involved in the production of a Climate Service. This implies the cooperation between various (climate) data and information providers as well as the relationship to users to guarantee usefulness and usability of climate information. But also cooperation to political stakeholders to ensure appropriate data policies mandates and guidelines for the use of climate information.
Technical dimension	The ***technical dimension*** refers to the content of climate information and its relevance for a specific user, user-group or sector (e.g. parameters, indices, etc.). It also refers to the contextualization of climate information with respect to scale and resolution (temporal and spatial) but also format and style of presentation of climate information (e.g. maps, graphs, diagrams, etc.). And furthermore it comprises the quality of climate information and the provision and communication of meta-data and information on uncertainty along with the climate information.
Service dimension	The ***service dimension*** refers to dissemination and utilization of climate information. Dissemination comprises the provision of access to climate information (e.g. data policy, data platforms, etc.) but also promotion of climate information to enhance visibility and perception of the added value for the user. A critical aspect of dissemination is the timing of delivery and up-date frequency of climate information. Utilization refers to the support of the user in using climate

	information for his decision-context. This may comprise assistance for data interpretation, decision-support tools and advice for the implementation in decision- making processes as well as training and educational material on these issues.

The extent to which an NMHS can deliver services will depend on its capacity to access and process observational data, to manage and analyse climate data, to convert the data into relevant and usable information and products, and to contribute to the development of a range of products in support of decision-making. On the basis of these criteria, the capabilities of national climate services can be classified as:

1. Basic capacity;
2. Essential capacity;
3. Full capacity; and
4. Advanced capacity.

The purpose of this classification is to help countries better understand the capabilities required to provide climate, weather and hydrology services, and identify what is needed in their own NMHS to ensure the desired service level. A description of the capabilities expected of a NMHS at each level is provided in below. Members monitor their progress in implementation of climate services through the WMO Community Platform to identify areas where support is needed, on the basis of a country-focused results-based framework to support WMO contributions to the GFCS (WMO, 2016*b*).

Table 2: Description of the capabilities expected of a NMHS at each level

Level of capacity	Weather services	Climate services	Hydrological services	Description of capacity needed to achieve service level
Basic capacity	• Weather observations • Weather data management • Interaction with users of weather data and products	• Climate observations • Climate data management • Interaction with users of weather and climate data and products	• Hydrological observations • Hydrological data management • Interaction with users of hydrological data and products	• Small network of quality-controlled observations • Basic data-processing, archiving and communication systems • Little or no backup/offsite storage or contingency options • Staff: observers and some meteorologists trained to Basic Instruction Package (BIP) standards • No 24/7operation • Rudimentary quality management system • No research and development
Essential capacity	• Medium-range (synoptic scale) forecasts and warnings • Established links with media and disaster risk reduction (DRR) communities	• Seasonal climate outlooks • Climate monitoring	• Hydrological data products for design and operation of water supply structures • Water level and flow monitoring • Short-term flow forecasts (low flows) • Flood forecasting	• Ability to take and integrate observations from other parties – including harmonisation of monitored and processes outputs • Well-established protocols for emergencies, backup of data and minimum offsite facilities • Staff: observers and meteorologists trained to BIP standards • 24/7 operation. • Well-established quality management system • Ability to access most numerical weather prediction data/products from other centres • Ability to access own monitored data and products. Either as a row data or in a form of on-line services. • Small research and development unit • Some partnerships as junior members
Full capacity	• Specialized weather products for a wide range of sectors • Well integrated into DRR communities and mature links	• Specialized climate products • Decadal climate prediction • Long-term climate	• Seasonal stream-flow outlooks • Specialized hydrological products	• Advanced observation equipment • Systems and capacity to develop and disseminate climate information to end-users (e.g. in agriculture) – including access to data. • Ability to run its own numerical prediction suite • Research and development unit

	with media	projections		• Well-educated/trained staff • Own training group • Developed library and information services • Active partnerships with NMHSs taking a leading role
Advanced capacity	• Customized weather products • Weather application tools	• Customized climate products • Climate application tools	• Customized hydrological products • Hydrological application tools	• Advanced observations • Leading research and development teams • Well-developed education and training unit

3. STATE OF THE CLIMATE INFORMATION SERVICES IN NORTH MACEDONIA

3.1. PROVIDERS OF CLIMATE INFORMATION SERVICES: NATIONAL HYDRO METEOROLOGICAL SERVICES

The following information is based on a self-assessment carried out by the NHMS regarding its capacity and activities carried out by the institution. It also includes – where applicable – information gathered from feedback from other stakeholders.

3.1.1. INSTITUTIONAL DIMENSION

Overall categorization: Essential capacity / full capacity

Notes where improvement is possible: Based on feedback received, the NHMS is operating at a high level with regards to institutional coordination with key ministries, the Crisis Management Centre, and international partners. Improvement may be possible in cooperation with academic / research institutions within North Macedonia and formalization / automatization of some relationships with some of the relevant departments the Ministry of Agriculture, Forestry, and Water Economy as well as with the main energy company and/or Energy Agency.

3.1.1.1. National legislation on climate services

The authority of the NHMS is established within the legal framework by the Law on Hydrometeorological Activity (Official Gazette No. 103/2008; No. 53/2011; No. 51/2015; No.149/2015). Article 9 defines the NHMS activities in the field of application of meteorology and hydrology, that include providing with hydrometeorological information and products on weather, water, climate and environment for the necessity of governmental institutions, public, physical and legal persons, nongovernmental organizations, media and other users; etc.

There is no national strategy/policy for climate information service specifically, although the NHMS is familiar with the goals of the GFCS and recommendations for the preparation of a national strategic plan and action plan for implementing a National Framework on Climate Services (NFCS).

The NHMS is a self-contained Governmental institution within the institution of the framework of the Ministry of Agriculture, Forestry and Water Economy (MAFWE), acting as a legal entity.

3.1.1.2. Coordination mechanisms

The NHMS participates in a number of coordination mechanisms and projects at a regional / global level as well as at the national level. In recent years the NHMS has successfully participated in realization of more projects and programmes such as:

Regional / global:

- Project ***"Drought Management Centre for South East Europe (DMCSEE)"***
- Twinning project ***"Strengthening the Central and Local Level Capacities for Environmental Management in the area of air quality"*** (with the Finnish Meteorological Institute).
- ***Regional Cooperation in South Eastern Europe for meteorological, hydrological and climate data management and exchange to support Disaster Risk Reduction*** – through which:
    - The Republic of North Macedonia became a member of European meteorological institutions such as EUMETNET network and associated member of the European Centre for Medium-Range Weather Forecasts (ECMWF), by which the access to the products, data and software is enabled.
    - A mechanism on cooperation in the region of South-East Europe has been established for strengthening the capacities of the service in regard to the seasonal, that is long-range predictions and climate watch by participation in permanent sessions of South-East Europe Climate Outlook Forum-SEECOF.
- Project ***MEditerranean climate DAta Rescue (MEDARE)*** is an initiative, born under the auspice of the World Meteorological Organization, with the main objective is being to develop, consolidate and progress climate data and metadata rescue activities across the Greater Mediterranean Region.
- ***Climate Change Adaptation in Western Balkans Project – establishing a Flood Early Warning System for flood warning in the Drim-Bojana River Basin*** – supported by GIZ
- ***Eco-system based Disaster Risk Reduction – ECO-DRR***, Crisis Management Centre, JICA

National:

- Project "Mitigating climate change through improving energy efficiency in building sector"
- Strategy for adaptation of health sector from climate change in the Republic of Macedonia
- "Restoration of the Struma River Basin Project" and "Reducing Flood Risk in the Polog Region Project" – supported by UNDP
- "Programme on meso-meteorological measurements in the Skopje valley and its realization"
- "Macedonia's Fourth National Communication and Third Biennial Update report on Climate Change under the UNFCCC(4NC3BUR)" supported by UNDP
- "Increased resilience of agriculture sector through promotion of climate smart agriculture practices" FAO TCP/MCD/3705 with the Executing Agencies: MAFWE, NHMS

The level of cooperation can be considered as rated high with regards to other hydrometeorological institutions. In the scope of performing the activities within the project tasks, active inter-department communication at the national and international levels is standard.

At an international level, NHMS's experts are included in WMO activities. Currently, the national focal point for climate services information system is Suzana Alcinova Monevska. There are experts involved in various Technical Commissions, also national focal point on Climate Service Information System, etc. By participating in these projects and activities the Hydrometeorological Service has a noticeable benefit such as receiving technical support for strengthening the meteorological observing system (installation of automatic meteorological stations), the education of professional staff and the use of joint methodologies in carrying out the activities in meteorology, climatology and

agrometeorology. The NHMS exchanges data and products on a regular basis with ECMWF, EUMETNET, EUMETSAT as well as other relevant international organizations. As a part of Europe Meteoalarm System (EUMETNET), the NHMS provides alerts and the most relevant information for extreme weather.

At the national level, there is no specific national coordination mechanism especially dedicated for climate information services. There is a Memorandum of Understanding (MoU) between NHMS and the Ministry of Environment and Physical Planning (MoEPP) for cooperation and realization of the Projects ***"Strengthening Institutional and Technical Capacities for Improving Climate Change Transparency under the Paris Agreement"*** and ***"Fourth National Plan and Third Biennial Climate Change Report"***.

There is no institutionalized cooperation with the MAFWE's Rural Development Department. A similar situation exists with the Phytosanitary Department – the department responsible for the creation of the national policy and legislation in the area of plant health and plant protection products (PPPs). To date, the Phytosanitary Department notes that there is excellent cooperation with NHMS in providing detailed data regarding climate and weather conditions in the certain regions of the territory of the country but this is not institutionalized via a specific ongoing agreement. The cooperation between two institutions will in the future be focused on IPM (Integrated Pest Management), more concretely on the establishment and management of the agro-meteorological stations in terms of prognosis of development of pests. With this approach, it will be ensured sustainable production of agricultural plants along with minimizing the risks in the process.

The following diagram shows the basic value chain of the climate information services provided by the NHMS.

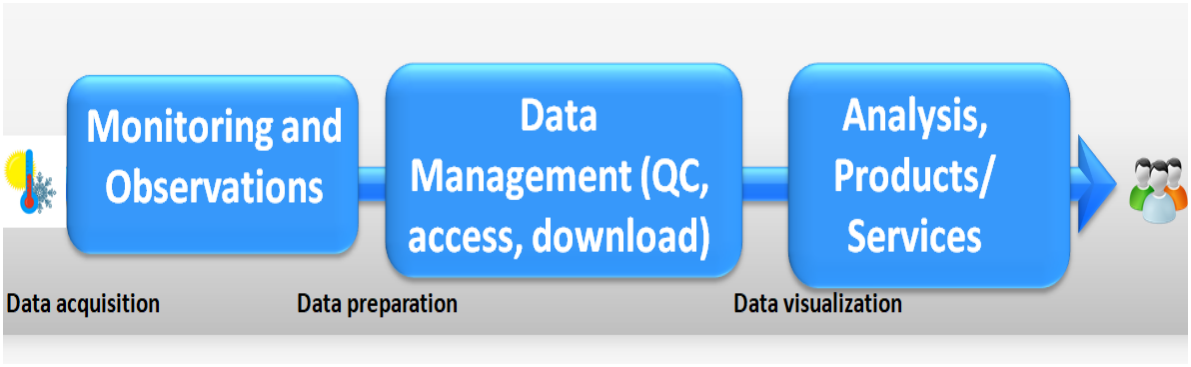


Figure 3: Value chain of climate information services provided by the NHMS

3.1.1.3. Early warning systems (EWSs) and disaster risk reduction (DRR)

NHMS's involvement in early warning systems and disaster risk management is governed by the law describing its responsibilities.

For early warning systems (EWS), the EUMETSAT Meteoalarm System is operational. A multi-hazard national EWS is planned as part of the updated National Platform for DRR (September 2019) which has been adopted by the Government. In addition to addressing various disasters (earthquakes, epidemics, fires, terrorist attacks etc., the system will also address weather and climate change risks (heat waves, floods, storms, heavy snow loads, droughts etc).

Related to disaster risk reduction (DRR), according to the National Platform for DRR, NHMS provides alerts / warnings to the Crisis Management Center. The NHMS also provides a relevant member for the Governmental Crisis Headquarter that is established in a crisis declaration. With its user access, NHMS is included in the European System for Early Warning of Floods (EFAS) and the Flood Warning System (FFGS) which is part of the program for hydrology and water resources of the WMO. For the system to fully function, in the coming period it needs to be supplemented with radar data from at least one new radar. The NHMS is also part of the Next-Generation Incident Command System (NICS) for mutual communication and management of institutions in the event of natural disasters, which is supported by the NATO scientific Program for Peace and Security, and also requires constant communication with the WMO.

The NHMS maintains a meteorological basis for the elaboration of agrometeorological, climatological, and biometeorological analyses and forecasts. It provides timely reporting on hydrological, meteorological, agrometeorological, climatological and biometeorological conditions to the Crisis Management Centre (CMC), to allow for appropriate measures to be taken by the relevant institutions. The NHMS has signed a memorandum of cooperation with the CMC to allow for the delivery of data on a daily basis normally and additionally on an ad-hoc basis when needed in exceptional situations. Coordination at the local level regarding EWS is carried out by the CMC through its regional units and through Protection and Rescue Directorate. The CMC delivers data daily to its 35 regional crisis management centres in the country including the municipal units and other users.

Additionally, related to **environment and climate change**, there is regular cooperation and data sharing with the MoEPP related to the collection and sharing of data (for example for the production of national communications to the UNFCCC).

3.1.1.4. Cooperation with research and private sector institutions

It was noted by the academic institutions which provided feedback and with the energy company ESM that there are no relevant formalized cooperation agreements with the NHMS. There is a Memorandum of Understanding (MoU) between the NHMS and the Faculty for Natural Sciences (mostly for educational purposes) but not with the other relevant academic institutions surveyed for this report. Almost all activities are at the level of individual contribution of researchers from different research institutions for specific activities wherein the goals of the NHMS align with those of the institutions. It was noted by one respondent that the information available with relative ease to academia is very basic data. In some cases, researchers (for Masters or PhDs) have submitted an official letter based upon which specific data was shared. For the needs of some scientific projects it is reported that a certain amount of money should be paid but there is no official price list.

In the same time, there is a National Committee for Climate Change where the leading institution is the MoEPP, and there are 23 members (mainly state institutions) that cover different sectors. When a certain strategy, plan, project or report is prepared, experts from the specific fields are typically hired, which often includes members of academic institutions.

3.1.2. TECHNICAL DIMENSION

Overall categorization: Basic / Essential capacity

Notes where improvement is possible: Based on feedback received, the NHMS is operating at a level between a basic and essential with regards to technical capacity. Improvement is necessary regarding equipment. It would also be value added to more fully automate information sharing with, for example, the agricultural sector, energy sector and perhaps other stakeholders (e.g. publicly funded academia).

3.1.2.1. Meteorological system condition and data collection

The first meteorological-climatological measurements and observations on the territory of the Republic of North Macedonia were carried out in 1923, although individual measurements and observations existed from 1891 to 1898 (in Skopje) and from 1896 to 1912 in Bitola, as well as during the First World War in Strumica, Prilep, Bitola and Udovo. In 1923 a precipitation station network was organized for the requirements of the former Ministry of Civil Engineering and Waters. These measurements were completed in the beginning of the Second World War. In 1942 a meteorological station network was established in the organization of the former authorities, which existed till 1944. A decision on organizing the Hydrometeorological Service was made in 1947, when a network of main, climatological and precipitation stations was established. The meteorological station network has existed since then with some breaks and with improvements in the programmes of work.

The Meteorological system is integrated into the global observation system and all activities which are performed in this system are carried out in accordance with the regulations and standards of the WMO. The meteorological station network with professional observers currently includes 19 main meteorological stations and 2 meteorological radar hail suppression centres. Additionally, there is a network of stations with part-time observers, which consists of 12 climatological stations, 116 precipitation, and 24 phenological stations.

In recent years, the meteorological observation system has been strengthened with the installation of automatic meteorological stations (AMS) - resulting in a total number 14 stations (two of them are for aviation needs). This was undertaken under the auspices of several projects realized with the participation of the Meteorological Department of the NHMS. In this way the quality and quantity of meteorological data have been improved by establishment of 24-hour monitoring. A negative characteristic of this system is the existence of different types of automatic meteorological stations (different projects – different producers), where the following occurs:

- difficulties in maintenance, calibration, purchase of spare sensors and other parts,
- existence of different software for communication with stations, data reception and processing,
- variety in the form in which data are received: data reception, processing and archiving from different AMS.

The maintenance of the established automatic meteorological system incurs problems due to:

- a lack of staff
- insufficient training of existing staff for work with AMS

- lack of funds for quality maintenance of AMS (purchase of spare sensors, operating supplies, technical equipment for electric sensors control and calibration).

The NHMS reports that the digitalized meteorological data in the climatological database – CLIDATA – is being increased to a great extent by the project activities, which provide a good basis for providing basic data for various needs and investigations in climate of the Republic of North Macedonia. The process of digitalisation is also being undertaken in terms of the rescue of historic meteorological and climatological data (***DARE*** – Project of high priority within the WMO Programmes). The rescued data in combination with more accessible data enables better analysis of climate variability and evaluation of climate projections for the future.

A long series of climatological data has been developed for the main meteorological stations, which enables to estimate indices of extreme climate events (appearances of hot and cold waves, dry and wet periods, extreme temperatures, flood rains etc.) according to WMO instructions. Use of the same definitions for extremes and data analysis in a standardised way enables the comparison of results from different locations for providing a coherent presentation of the changes in the region and beyond.

The Hydrometeorological Service faces serious problems performing the operative-technical duties because of lack of field vehicles. The motor pool of the Service is old and cannot satisfy the requirements for regular and quality performance of works and intervention upon the appearance of breakdowns and stoppage of meteorological measurements.

Additionally, in order to better forecast heat waves, frosts, evaporation, irrigation scheduling, etc. the Consultant notes feedback that there is a requirement for a much denser network of stations and improvement of technical capacities.

3.1.2.2. User interface platforms and other cooperation

Regarding specific user interface platforms, there is no specific framework for these platforms, but the NHMS on a regular basis provides relevant ministries with weather forecasts, climate outlooks, seasonal forecasts and data on request. Data sharing occurs in a systematic way with the CMS and with the media related to weather reports. Most of the interactions with other users (academia, the main energy company – ESM etc.) are on an ad hoc basis. This ad- hoc interaction based on specific needs / requests includes interaction with some of the departments of the MAFWE such as the Administration of Water Economy.

The available budget of the NHMS does not allow for the establishment of an efficient Climate Services information system beyond the basic data already available (which is already stretched). Enhanced data collection and sharing based on available meteorological, climatological, and agrometeorological data would require additional financial resources as well as efforts for rearrangement the greater budget resources for the most basic current system maintenance.

It is noteworthy for agriculture that there is a Soil Map of the Republic of N. Macedonia which has data accessible through its internet web-portal (www.maksoil.ukim.mk),which is largely included in various climate actions, or Agro-Ecological Zoning Projects etc.

3.1.3 Service dimension

Overall categorization: Essential capacity

Notes where improvement is possible: Based on feedback received, the NHMS is operating at the level of essential capacity with regards to the service dimension. Information is disseminated quite well to some stakeholders (e.g. Crisis Management Centre and Ministry of Environment and Physical Planning) while dissemination practices could be improved in other areas such as through the digitalization of data. Improvement is necessary regarding staffing – especially regarding training and looking towards engaging younger professionals within the organization.

3.1.2.3. Production and co-production climate information services

The NHMS is the primary organisation providing climate information services in North Macedonia. Although some organizations perform meteorological measurements for their specific needs, none are providing climate and/ or hydrological services in the sense described within this report.

The first-level users of climate information at the national level are the general public and the media (for weather reports) along with the following institutions: CMC, MAFWE, and MoEPP. Additional research actors and ESM have noted that – based on specific requests – the NHMS will provide data and information.

Regarding feedback mechanisms on the quality of services, there are generally no specific mechanisms for this, but rather ad-hoc discussions with specific users (for example the MoEPP providing feedback related to climate change projections for developing to the National Communications to the UNFCCC).

Regarding tailoring of information, there are basic capacities for this that require improvement as reported by the NHMS. There is no National Action Plan for CIS, the activities regarding climate and hydrology products and services are funded from both national budget and donors. The NHMS has developed a proposal for a National Framework on Climate Services with National Action Plan – which has been incorporated into this report including a budget for activities (see Section 4).

It was noted by the NHMS that there are no specific regularly tailored services provided – though some are performed based upon requests.[6] The Pilot Case for tailored climate information for agriculture was performed within the completed FAO Project “Strengthening the capacity to respond to climate change in the agrometeorological sector”[7] and was reported to be very successful. The AGROMETEO- website provides regular tailored information for farmers only for three regions in the country. Namely: frost alarm, plants disease alarm, weather condition alarm for field/plant spraying. It is planned to have weekly information for farmer for the whole county.

The quality of data provided is reported as being high by the various stakeholders providing feedback – where the data is available and shared. The Faculty of Natural Sciences and

[6] Previously the NHMS provided printed monthly reports with decade averages for the main meteorological parameters. The Consultant notes that in their experience this was very useful or the stakeholders, but it was stopped a long time ago.

[7] http://agrometeo.mk/

Mathematics, Skopje, UKIM, Department of Geography noted that many of the products they would need are not available. ESM noted that the current types of climate information products that ESM is using are appropriate – though additional data and products will be necessary to help gain climate information in advance in order to plan ahead a more efficient energy production.

It was recommended by a number of actors that formal agreements between the NHMS and specific institutions be concluded and implemented for the permanent and regular flow of information and data. This could include, for example:

- **MoEPP** - which noted that tailored data and data sharing can be improved through the establishment of specific protocols and procedures for data sharing, as well as the improved transparency of the data;
- **MAFWE's Rural Development Department and Administration for Water Economy –** where there appears to be a fair amount of data shared, but only on the basis of specific written requests and not in a systematic ongoing way;
- **ESM –** which noted that digitalized information gathering, databases and forecasts would improve the planning of energy production, which would later result to lower losses of energy sources and higher energy production.

It should be noted that currently, the NHMS is not working closely with other organisations for the co-production of CIS. The MoEPP supports the NHMS by involving them in different Environment and Climate projects – though does not assist in the production of information. There is also no permanent cooperation with academia.

Related to the digitization of data, Agrometeorological data, Phenological data, and Hydrological data are partially digitized but not entirely. Quality control of the data includes the following:

- Basic logical and statistical control is partly performed (mostly on a data from conventional measurements).
- Homogenization is also partly performed on some monthly data.
- Data from precipitation stations are logically controlled.
- Phenological data are not controlled and not homogenized.
- Hydrological data are partly controlled.

Regarding the data, the central database for data acquisition, archiving and management of meteorological data is ***CLIDATA.*** The hydrological database partly integrated with the meteorological data, while the phenological online database is in SQL.

As reported by the NHMS, there are gaps in the data and also suspicious data. The gaps in the data from the main meteorological stations range from several days up to several months. The gaps in the data from climatological stations are longer, some of them to a level of complete shut-down. There is awareness of the need for data rescue, but has not been operationally organized.

There are various products available (like average data, extreme values, etc.), but they are not in an open database. Many of them are available online on website of the NHMS while others must be specifically requested.

The country does not have an updated climatic atlas. The reference climatological period in use is mostly 1961-1990 and 1981-2010.

Regarding a national observation network for climatic purposes, this exists though the NHMS reports that it should be updated by elaboration of a Rulebook on the national observation network and accompanied with sub-legal acts, as well.

The NHMS reports that there are **analyses of climatic extreme events at national and subnational levels. Hydrological extreme events are partially analysed.** Along with this, the NHMS analyses climatic trends to detect climate change at national and subnational levels. Furthermore, the NHMS uses data derived from climate change scenarios for analysis and application. This information is shared with different stakeholders and decision-makers upon request – including via longer-term cooperation such as in the preparation of the National Communication to the UNFCCC and the Biennial Update Reports.

3.1.2.4. Existing staff / capacities

The Meteorological Department at the Hydrometeorological Service has for an extended period faced the continuous problems in carrying out its obligations due to a lack of appropriate staff. Regarding the highly-educated staff in the Republic of North Macedonia there are unemployed graduated meteorologists, while at the same time meteorological technicians are no longer being educated in the country.

The situation is most problematic in regard to the realization of the programmes for work at the stations in the meteorological observing system network in Macedonia. Because of the inadequacy of the programme for work and the number of employees at meteorological stations in 2003, the programme for work is reduced to the most basic level, which has resulted with problems only being partially solved, and a decrease in the availability of meteorological data as well. The situation is additionally worsened because of more frequent absences from work as a result of illness, and lack of new employees filling posts after retirement, or by other reasons.

Therefore, during the last several years a great number of posts have been vacated in the Meteorological Department due to various reasons and this process is expected to continue in the coming years taking into account age structure of employees.

Considering the continual implementation of a 24-hour programme of work, the specific meteorological station locations, as well as age structure of employees there are no real possibilities of internal re-arrangement of staff in the Hydrometeorological Service. Employment of inappropriately educated persons requires longer training and qualifications before their active involvement in the process of independently performing of specific working tasks.

Because of these issues, work has been stopped at:[8]

- aerologic observatory – Petrovec,
- main meteorological station – Solunska Glava,
- main meteorological station – Popova Shapka

[8] The NHMS notes that “Keeping in mind that the obligation of the state is to deliver daily data from meteorological measurements and observations at meteorological stations to the global exchange data system according to the resolutions of the World Meteorological Organization, each break represents a iolation of undertaken international obligations.”

Along with the general issue of staffing, there is **a particular issue related to occasional observers** Pursuant to Article 16 of the Law on Hydrometeorological Activity, the Hydrometeorological Service performs monitoring of meteorological stations by employing occasional observers, and the Service pays an allowance to the observers according to the Decision on Determination of allowance Cover for Performing Hydrometeorological Works Involving Occasional Observers (Official Gazette No. 19-747/1 from 24 February 2009). Monthly allowance of occasional observers ranges from 560 MKD to 7520 MKD (EUR 9 to EUR 123) depending on the type of measurement. The available budget funds for this assignment in the last years were insufficient for payment to the occasional observers, therefore the payment is consistently (and permanently) late.

Because of the continual lack of funds for payment to the occasional observers in the previous years, the number of meteorological stations with engaged occasional observers has been drastically reduced and therefore the number of precipitation stations has been reduced. In the past the precipitation station network included up to 300 stations, and during recent times this number has been reduced dramatically. The greatest reduction took place in 2003 when the number of stations was reduced from 196 to 155 and in 2012 this number was reduced to 116 stations.

Due to this, the amount of basic meteorological information is drastically reduced taking into account that this information is the essential for flood protection, climate and water resources investigation, preparing the studies for construction of large buildings of the state importance and for the necessities of health, agriculture, forestry, biodiversity and environment in general.

Regarding training needs, it is reported by the NHMS that there is a high level of experience in the national climate data, but the capacity level for management of the data should be increased.

The NHMS has also noted that there have been some occasional workshops for climate information services specifically at an international level, but that financial constraints usually prohibit their participation – though it would be value added to enhance their capacity to carry out the various aspects of climate information services.

The NHMS also considers that there is a need to train its staff on:

- Tailoring climate information for different sectors (e.g. agriculture, energy, transport, etc.) and on different levels (e.g. information/data provided to the farmers and research agricultural institutions and others).
- Monitoring / Database / Climate data presentation for climate change purposes
- High level trainings on meteorology, hydrology, agrometeorology, observation system, weather forecast, calibration, EUMETSAT satellite products, etc.
- Benefits of climate products and services for successful planning.

The targets of these trainings should be all professional staff, in order to generate products and services on a regular base, that would be easily usable by stakeholders.

The mechanisms for such trainings should be decided in further discussions with the NHMS including choosing specific modules, themes, and audience members. Follow-up activities that would be the most helpful would include performing of a case study for different regions in the country, for different stakeholders and priority areas (agriculture and food security, disaster risk reduction, energy, water and health).

It was noted that there is currently no system for recording technical (climate related) trainings for NHMS staff available or any annual Plan for training for staff working in climate information service units.

3.1.2.5. Communication channels for climate information delivery

The following communication channels are used by the NHMS in communicating with the relevant departments / organisations – including an assessment by these organisations as to their relevance, quality, and reliability.

Table 3: Types of communication channels used by the NHMS

Type of communication channel	**Institution**	**Relevance** *(Low, Medium, High)*	**Quality** *(Low, Medium, High)*	**Reliability** *(Low, Medium, High)*
Climate extremes and scenarios	**MoEPP**	*High (including on a project basis for the MRV unit)*	*High (including on a project basis for the MRV unit)*	*High (including on a project basis for the MRV unit)*
Data relevant for the vulnerability and adaptation studies	**MoEPP**	*High (including on a project basis for the MRV unit)*	*High (including on a project basis for the MRV unit)*	*High (including on a project basis for the MRV unit)*
Written documents	***MAWFE Administration for Water Economy***	*High*	*Low*	*Low*
Web based data	***MAWFE Administration for Water Economy***	*High*	*Low*	*low*
Official letters between the two institutions	***MAWFE Phytosanitary Department***	*High*	*High*	*High*
Written documents between the two institutions	***MAWFE Rural Development Department***	*High*	*Low*	*Low*
Web based data	***MAWFE Rural Development Department***	*High*	*Low*	*low*
Email and/or audio conferencing	***ESM***	*Medium*	*Medium*	*Medium*

It was noted by the NHMS that most uncertainties related to data are verbally explained and there is no standard operating procedure for describing and including uncertainty.

As has already been noted, weather related early warnings are disseminated to the Crisis Management Centre, Ministries, the Media and the public. Climate related early warnings are generally disseminated to the public through the media.

The public awareness about the benefits of the use of climate information services is considered low by the NHMS who believe it should be increased. The best way to do that would be through successful national examples in their opinion.

It was noted by the **Agency for Promotion of Agricultural Development (Extension services) (NEA)** that there are no direct structured communication channels between them and the NHMS. The NEA receives climate information products usually through project activities conducted by non-governmental organizations (RDN, Cepro Sard, SWG) in the form of reports, summaries, or global datasets, like FAO.stat, WorldClim etc.

They also noted that there is need for dissemination of the information's to the primary producers (farmers and farm holdings) and therefore delivery of such climate information services to NEA will be of significant importance in implementing of certain adaptive measures to climate change in the agricultural sector.

Based on the feedback from actors not operating within the policy-making function of the Government (extension services, ESM, and academia), with the exception of the CMC, it seems that the communication channels for dissemination of data could be expanded to include a broader audience. Such activity would need to be accordingly supported with a programme of work and financial resources.

Regarding communication channels the following channels were recommended by stakeholders for sharing of information:

- The internet site www.klimatskipromeni.mk or other web-based platforms - **MoEPP, MAFWE**
- The MAKFFIS platform for monitoring fires in forests. An institutional approach to all climate data that are available is welcomed - **Crisis Management Centre**
- Entrance in database by web, certain calculations, especially for low height of wind measurements - **Energy Agency**
- SCADA, as this is where monitoring on all power plants is provided **– ESM**
- The Consultant also notes that the Macedonian Soil Information System may be a good avenue: www.maksoil.ukim.mk

For information sharing with ESM, a three-step approach was proposed by the company:

1. Preparation of a study with the gaps of all power plants.
2. Preparation of documentation for ordering the necessary equipment and software for climate data collection, integration and forecasting of the power generation with sophisticated methods and software.
3. Implementation of the products, testing and running.

3.2. USERS OF CLIMATE INFORMATION SERVICES

This section assesses the current level of involvement and how climate information services are used by various actors / sectors in North Macedonia. It includes information on the kinds of climate information services which would be considered valuable.

3.2.1. UTILISATION OF CLIMATE SERVICES AND INTEGRATION INTO PLANS

The current users of climate information and the purposes used are as follows:

- **MAFWE Rural Development Department and Phytosanitary department:** Receive / use the following for the purposes of strategic planning and programing of rural development measures as well as for the purposes of prognosis of weather conditions.
    - climate monitoring products
    - seasonal /interannual/decadal predictions
    - climate projections
- **MAFWE Administration for Water Economy:** Receives / uses climate monitoring products - mainly could use information on losses of water in open canal systems, and different approach on drainage systems
- **MoEPP (including National Environmental Information Centre and Department for Nature):** Receives / uses climate monitoring products and climate projections for development of chapters on climate projections and vulnerability assessments in different sectors. This information is used for the creation of environment and climate long-term policies and other Sectors Management Plans, especially in the areas of vulnerability and adaptation to climate change. The inputs are also used to fulfil reporting requirements towards the UNFCCC.
- **MAFWE Administration for Water Economy:** Use climate information for assisting in water management and JSC Water Management of N Macedonia as operational institution regarding irrigation and drainage.
- **Crisis Management Center:** The users of climate information are: Sector for Operation and Coordination, the Sector for analytics, evaluation and strategic planning, and Regional Crisis Management Centres in 35 municipalities in the country. This information is used for operational planning documents for fires, floods, draughts, extreme temperatures, snow falls, avalanches and drifts that cause interruptions on roads, assessment of risks, dangers and safety in the country, etc. The CMC receives / uses:
    - climate monitoring products – daily weather forecasts, levels of rivers, lakes and other water flows in the country, forecasts for heat or cold waves, floods, fires at open space, etc.
    - seasonal /inter-annual/decadal predictions
- **The Energy Agency:** Utilisation of the information system for evidence of consumption of energy in public sector, where NHMS office should maintain the climate data in IT system (which ties into normalization of energy consumption), but the IT system itself is out of function.
- **EMS:**
    - Currently for the day-ahead forecasting and units planning, the Company uses only historical short-term and long-term database with the power generation data and engagements of all units
    - On the location for potential extension of the wind power park Bogdanci they have a measurement tower for collection of the necessary wind data
    - Rainfall data is used for hydropower plants to assess possible storage regulation in some cases
    - Hydropower plants in some severe cases use the rainfall daily forecast when there is a bigger amount of rainfall in order to regulate the storage discharge and avoid the potential overflows.
    - Data is used in the initial phase of implementation of the solar power plants and for forecasting tools

    - The climate data and climate products will be collected for the future projects of photovoltaic power plants, which are currently under preparation or realization.
- **Academic / research institutions:** For specific project activities or for the needs of preparing a master's thesis or doctoral dissertation[9]. Also, for modelling of the average and extreme climate data for scientific purposes[10].

Regarding the integration of climate information services into relevant sectoral policies, many of the stakeholders (all of the Ministerial departments) providing feedback indicated that climate information is incorporated into their strategies and action plans – especially during the current processes of development. While this may not be formalized within the processes, it does seem to take place. MoEPP noted that guidelines / methodology for integrating climate information services is available on www.klimatskipromeni.mk.

The **CMC** noted that climate information is partially included but the process for integrating the information services on extreme events is needed.

ESM noted that for rainfall data in the hydropower plants there is an existing tool for integrating information into planning. For the extension of the wind power plants they are using the measurement data from the existing measurement tower. For photovoltaic power plants, they plan to use an integrated forecasting tool in the future. They expressed that there is somewhat insufficient current capacity to fully utilise climate information services.

3.2.2. CLIMATE INFORMATION NEEDED THAT ARE NOT CURRENTLY PROVIDED

The following outlines the climate information identified by stakeholders that are not currently provided and how they would be used:

- **MAFWE Administration for Water Economy:** The following would be useful for daily work and forecasting / planning
    - Daily discharge
    - Levels in the reservoirs
    - Inflow in the reservoirs (or correlation with some monitoring station)
    - Spring forecast of available water for melting of snow, etc.
    - Forecasting of available quantities of water for irrigation and probability quantities for drainage purposes.
- **MAFWE Phytosanitary Department:** There is a need of permanent data flow regarding climate conditions, even during the vegetative season on a daily basis. This Department is planning to establish a system within a current ongoing project for forecasting the appearance of certain diseases, as a part of the foreseen Integrated Pest Management System. For this reason they would need several weather parameters on a daily basis: e.g.: solar radiation, wind speed, air temperature and humidity and leaf wetness index.

[9] Noted by various respondents.

[10] Noted by the Faculty of Natural Sciences and Mathematics, Skopje, UKIM, Department of Geography.

- **MoEPP:**
  - More information on drought and floods predictions.
  - Euro codes that are in line with expected climate changes would be useful, as required by UNFCCC under the loss and damage mechanism, and to assess the build-in environment vulnerability to climate change.
  - Frost days detailed (both from monitoring and for future scenarios)
  - More detailed temperature and precipitation parameters rather than average values
- **Crisis Management Centre:** It was noted that there is no multi-hazard national EWS that exists at the national level – which is considered a large disadvantage.
- **The NEA** noted the need for a permanent flow of meteorological and climate data on a daily and weekly basis. They particularly highlighted the need for development of on-line services, especially for pest and diseases protection, irrigation scheduling, selection of most appropriate crop varieties, development and maintenance of early warning systems for frost, drought, late frost and extreme events.[11]
- **Academic institutions:** Specialized climate projections for different scientific areas or sectors (energy, forestry, agriculture, building construction etc). This could also include snow cover duration and height (yearly), extreme values of precipitations and temperatures (yearly), precipitation intensity per hours, winds frequency and directions etc. This information would be used non-commercially – for scientific and research purposes in modelling of the past and future climate changes, climate extremes and related natural and other hazards.

For the energy sector, it was noted that climate information services are needed to foresee the energy production of all units (HPP, wind, solar) in order to optimize the power generation mix, save energy, maximize revenues and effectively participate in the open market in the future. The current climate services need to be extended in order to gain additional benefit from this optimization:

- For the existing wind power units, the responsible counterpart for day-ahead hourly forecast of the power generation is MEPSO, the grid operator, using sophisticated methods and software.
- The forecasted generation of the future photovoltaic power plants has to be based on accurate climate data. Our company is planning to integrate the forecasting software in the existing SCADA.
- Climate information on temperature, wind, clouds, rain, and humidity would be required for forecasting of energy production of all power plants, including photovoltaic power plants.

Also, it would be very appropriate if it is possible to integrate climate / weather prediction models/software into the existing SCADA for short-term and long-term forecasting of all power plants with optimization of the resources in order to gain maximum benefit of the available energy.

It was also noted by the Energy Agency that climate information assists in directing possible investors in RES towards better resources, and also plays a part in calculating the obligations for issuing certificates for energy characteristics of buildings.

[11] The Consultant notes that this could be supported by academia as well through development of such services and its testing of its effects in practice.

3.2.3. POTENTIAL INVOLVEMENT OF STAKEHOLDERS IN PRODUCTION OF CLIMATE INFORMATION

There is likely some potential to involve other stakeholders in the production of climate information – or at least information which utilises climate data as an input into other knowledge products. Some information available includes:

- The **Crisis Management Centre** is not involved in large national projects; however, they are regularly requested to provide data that they have available (on losses, etc.).
- **MAFWE Phytosanitary department:** At the moment, they department is not engaged in the existing initiatives for climate information service. Recently, FAO and MAFWE initiated implementation of TCP/MCD/3705 - Increased resilience of agriculture sector through promotion of climate smart agriculture practices. Under the ongoing IPA Service project, Improved implementation of animal health, food safety and phytosanitary legislation and corresponding information systems the activities related to the basic integrated pest management system (IPM) are being developed on the basis of current laws (on Plant health and on Plant Protection Products), including the Training in Phytomedicine, with a view to the Annex I of Directive 2009/128 / EC (Article 5). Within the project, a Draft manual in combination of project support and annual program for Plant Protection Practices on MAFWE, including financing part of the program will be prepared.
- **MoEPP:** As part of an ongoing GEF/UNDP project, an MRV unit has been established within MoEPP to support establishment and implementation of transparent procedures and protocols for sharing climate data between institutions and other relevant counterparts.
- Within the **NEA** there are a number of experts which can contribute in estimation of the influence of climate change on agricultural production, as well as which climate information are needed for implementation of certain adaptation measures in plant and livestock production. A few years ago, NEA was engaged in a process of procurement of meteorological stations for measurement of meteorological parameters, which are unfortunately not installed yet. These six meteo-stations - one for each region - could be put into function and can supporting of the national network of meteorological stations. It should be noted that at the moment, NEA lacks the capacity to put them into function and manage them, but with appropriate training of staff NEA, they believe they can contribute to strengthening of the national network of meteorological stations, especially in the area of phyto-sanitary protection. **The NEA also notes** that they possess and system with appropriate software solution for easy dissemination of information to the farmers and farm holdings for certain climatic conditions, via SMS.
- The **Faculty of Natural Sciences and Mathematics, Skopje, UKIM, Department of Geography** also has Raster-based mean annual temperature, precipitation and snow cover of the national extent.

It is noteworthy that two of the academic departments which were surveyed relayed that they have sufficient capacities to manage climatic data. **The Faculty for Agriculture and Food - Skopje, Department for Field Crops** noted that regarding climate data obtained from the climate information system, their interpretation and use in certain climate models, the researchers involved in the agricultural sector have sufficient professional human potential that can respond to specific challenges, as evidenced by numerous documents and reports.

A similar response was recorded from the **Faculty of Natural Sciences and Mathematics, Skopje, UKIM, Department of Geography**, while the **Hans Em Faculty of Forest sciences, Landscape architecture and Environmental engineering, Department for Forest and Wood Protection** stated that there was not sufficient capacity. At the same time, it was noted by the Hans Em Faculty of Forest Sciences that there is a subject Ecoclimatology in the Faculty's curriculum, part in the subject Forest protection dedicated to climate change etc.

The **Faculty for Agriculture and Food - Skopje, Department for field crops** noted that their institution can provide information about specific crops related to climate parameters e.g.:

- specific needs for minimum, optimum and maximum temperatures for development of agricultural plants;
- influence of climate on length of vegetation season and shifting of the phonological phases;
- the needs for water during the vegetation i.e. : evapotranspiration, crop coefficients, water use efficiency

Thus, these Research Institutions can support the implementation of certain agro-technical measures, defining of land utilization types, agro-ecological zoning and Land Use/Land Use Change, which can be one of the first users of specific climate information. The big question noted by stakeholders is is how much of this information agricultural producers are familiar with and more specifically, how many of the proposed measures are applied in the wider agricultural production.

It was also noted that Research Institutes as organizations are not usually directly involved in existing initiatives where climate information services are used at national or local level. However, individuals (on behalf of the Research Institutions where they work), take part in certain activities and with their expertise and provide significant contribution to a specific project activity.

4. CONCLUSIONS AND RECOMMENDATIONS

Regarding the Institutional Dimension of Climate Information Services, the Consultant rates the overall categorization as between "essential capacity" and "full capacity". The legislative framework is clear and based on feedback received, the NHMS is operating at a high level with regards to institutional coordination with key ministries, the Crisis Management Centre, and international partners. Improvement may be possible in cooperation with academic / research institutions within North Macedonia and formalization / automatization of some relationships with some of the relevant departments the Ministry of Agriculture, Forestry, and Water Economy as well as with the main energy company and/or Energy Agency.

Regarding the Technical Dimension of Climate Information Services, the Consultant rates the overall categorization as between "basic capacity" and "essential capacity". Based on feedback received, the NHMS is operating at a level between a basic and essential with regards to technical capacity. Improvement is necessary regarding equipment, systems for agrometeorological stations (covering the agricultural land, producing data, analysing the data and delivering on-line services to the end users). It would also be value added to more fully automate information / data sharing with, for example, the National Extension Agency, the energy sector and perhaps other stakeholders (e.g. publicly funded academia).

Regarding the Service Dimension of Climate Information Services, the Consultant rates the overall categorization as "essential capacity". Based on feedback received, the NHMS is operating at the level of essential capacity with regards to the service dimension. Improvement is necessary regarding staffing – especially regarding training and looking towards engaging younger professionals within the organization.

Specific recommendations are as follows:

Identify resources for improved climate observation and processing / flow of information. Approximate sums of necessary financial resources for establishment and maintenance of Climate services information system have been developed by the NHMS and are included in Annex 1 – amounting to approximately 850,000 EUR. The Consultant notes that this sum may not be sufficient, and the budget with specific activities should be further developed to account for various improvements mentioned in this report. This could be mobilized as part of GCF support (or other donor support) with cofinancing from the Government. Additional budgetary resources may also be necessary for the re-mobilization of occasional observers.

Develop institutional coordination and ongoing information sharing with new actors including, for example, some departments within MAFWE (Rural Development Department, Phytosanitary Department), ESM, the NEA, and potentially with academia. For ESM in particular, this could involve a fee for service approach. Developing these systems will likely take significant technical assistance. This technical assistance could be mobilised for example as part of any GCF project (either in adaptation or mitigation) or from the EU's IPA Funds. The Consultant believes it would be useful to re-start the practice of dissemination of the raw data in digital format to various stakeholders.

Further automate information sharing: This could include publishing more information (databases) to the climate change website (www.klimatskipromeni.mk) or other web-based platforms. Automated weather forecast data sharing will be particularly useful for day-ahead and

hour-ahead electricity trading markets in the energy sector (for estimating PV and wind production). This activity is also important for services for the agricultural sector e.g. evaporation which is crucial for irrigation scheduling, max, and min, temperatures, forecasting of frost, hail, drought, or heat waves.

Further develop younger professionals and the overall team: This is partly linked to budget availability and partly linked to training and educational programmes – wherein newer staff need to be up-skilled to fully take over new responsibilities while existing staff can continue to build their skills.

Formalize a feedback mechanism: It would be useful to have a formal feedback mechanism (perhaps annually) to understand more fully the needs of climate information users, whether the NHMS is fulfilling those needs, and where there may be opportunities for enhanced impact.

The main recommendation regarding the users of climate information services is to **build off of this report to more fully crystallize a programme of operations / action plan for enhancing climate information services**. This could include more involvement of academia or other actors (such as the NEA) in generating climate information and / or processing this information for useful activities. After the process of building capacities (technical and staff-wise), the NHMS can then be officially mandated to produce more tailored products which to be defined in cooperation with the key stakeholders. These activities would need to be financially supported by the Government and / or on a commercial basis where appropriate.

ANNEX 1 – SUMMARY OF PROPOSED PROJECT ON CLIMATE INFORMATION SERVICES

PROJECT OBJECTIVE

The project objective is the establishment of a National climate services information system as an integral part of the regional/global information system on climate services within the World Meteorological Organization.

The necessity of establishment of a National climate services information system in order to generate, protect and distribute climate data and information results from the Law on hydrometeorological activity (Official gazette No. 103 from 19/08/2008) and obligations according to the conclusions from the Extraordinary Session of the World Meteorological Congress in 2012 for GFCS Global Framework for Climate Services establishment.

At the Third World Climate Conference in 2009 it was decided to establish a Global Framework for Climate Services (GFCS), as an international framework for leading the development of climate services. This global framework for climate services should enable strengthening production, availability, delivery and application of science-based climate prediction and services.

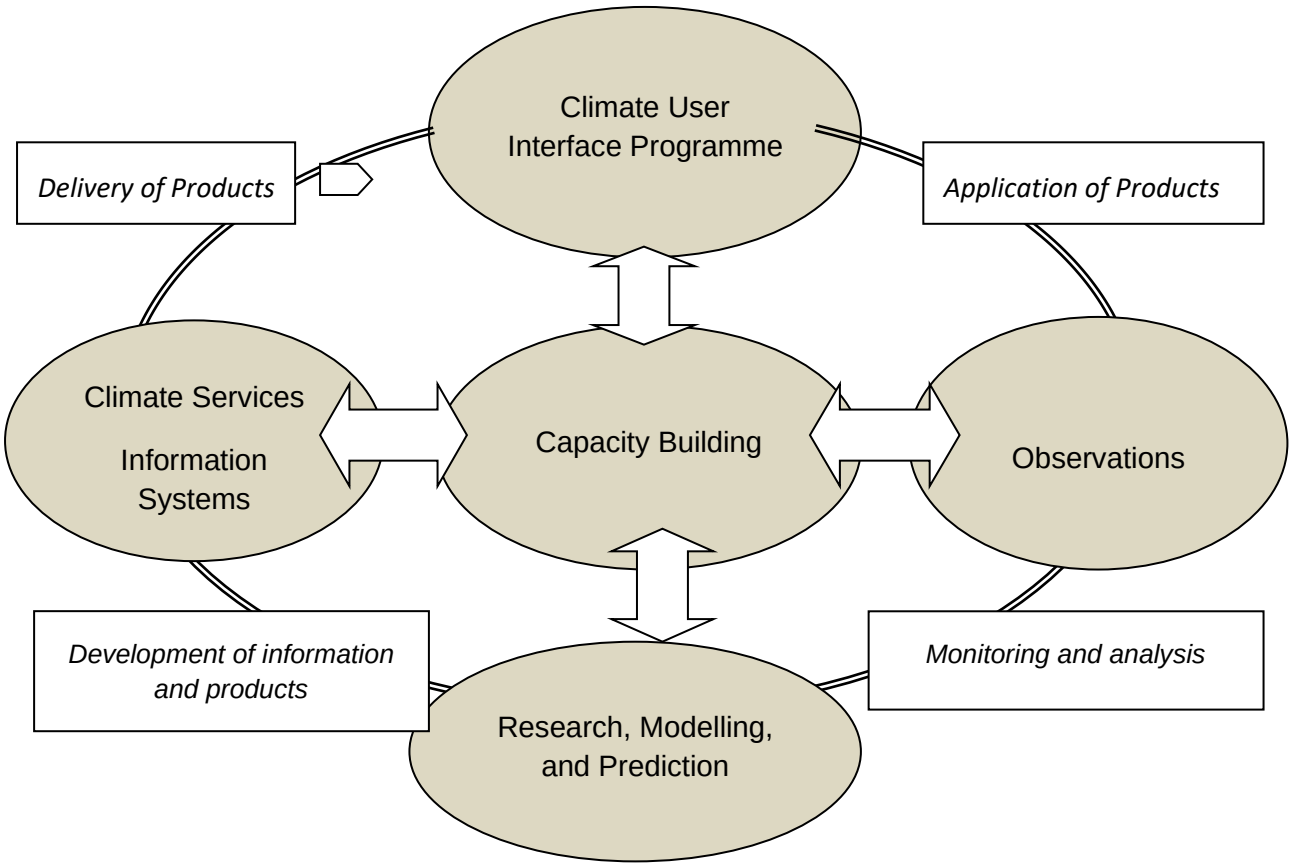


Figure 4: Global Framework for Climate Services

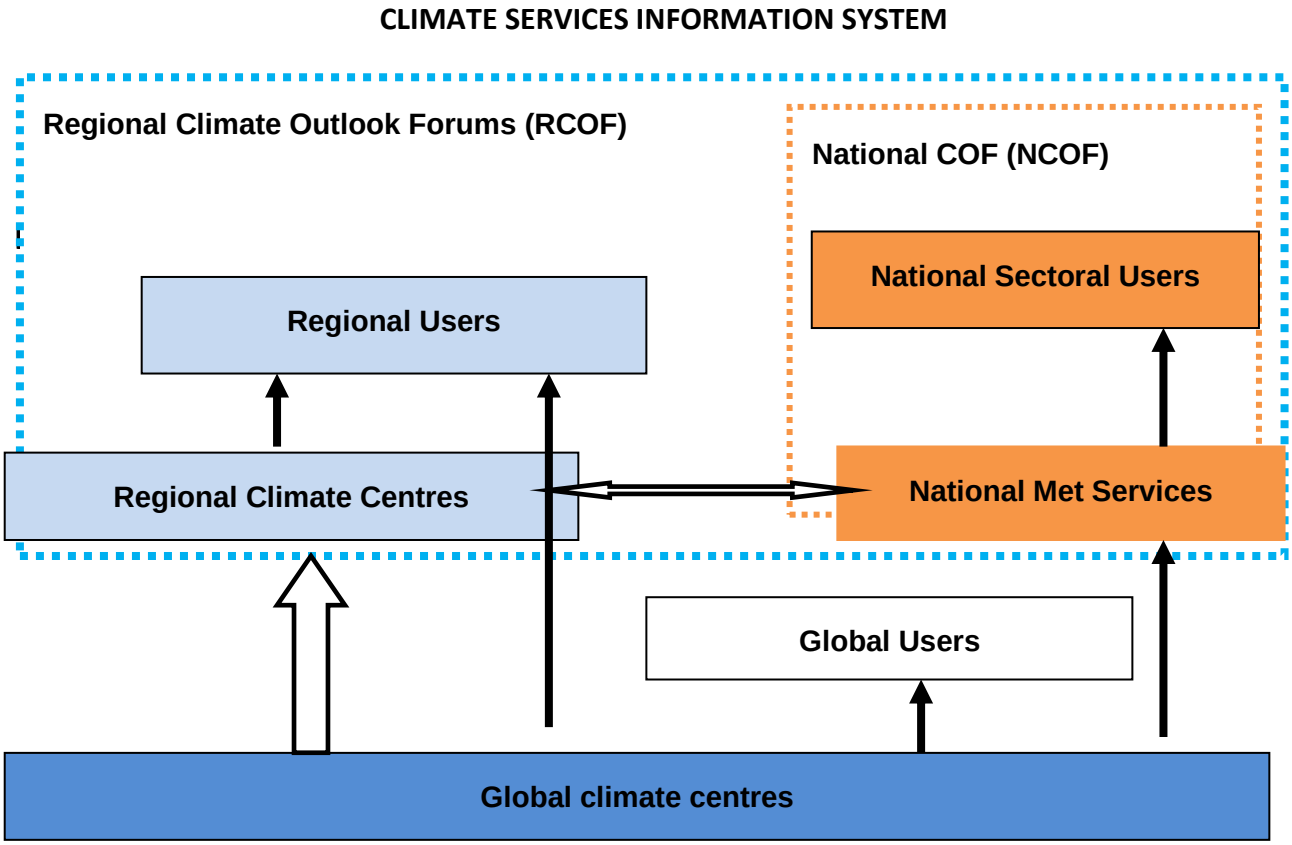
The main goals in the Global Framework for Climate Services are:

- Reducing the vulnerability of society to climate-related hazards;
- Advancing the key global development goals;
- Integrating the climate information usage in decision-making;
- Strengthening the engagement of providers and users of climate services;
- Maximizing the utility of existing climate service infrastructure.

Initial four priority areas of GFCS are:

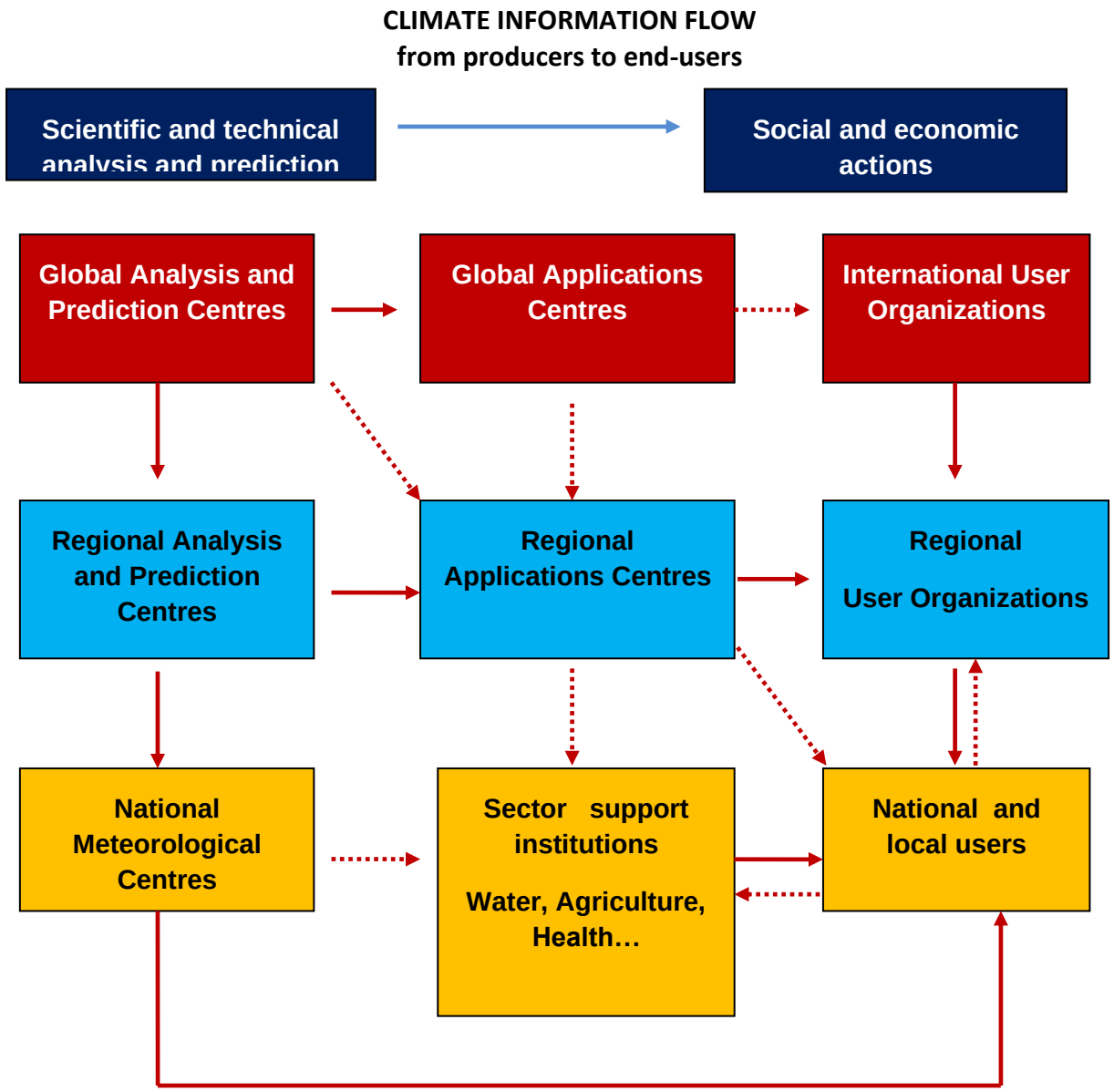
1. agriculture and food security;
2. disaster risk reduction;
3. health;
4. water resources management

The recommendation of the High-level Taskforce, constituted for GFCS implementation monitoring, is that there be three levels of Framework access in global, regional and national dimensions, with an appropriate course of data and information between all three levels.



Therefore, the establishment of a climate services information system (CSIS) is a key component of GFCS and it is designed for routine generating of climate information, including data, diagnostics, estimates, monitoring, predictions, projections etc., which are necessary to the users for wide spectrum of climate-vulnerable decisions at different levels.

Appropriate global and regional input data and products are essential for generating reliable operative climate information at national level.



The challenge of establishing a climate services information system is complex, but there are many prorities which will be realized by GFCS implementation: most importantly through the mitigation of impacts from climate variability and changes providing user-oriented climate services such as seasonal weather outlooks, droughts and floods noticing.

Climate services are more necessary than ever because of the fast increasing climate impacts, climate changes effects are evident and therefore it is necessary to take an action by application of science-based, user-oriented climate services in order to help in protecting the society, economy and environment.

A Climate services information system will enable decision strengthening at the disaster risk reduction, water resources management, health and agriculture and food security.

The urgent need of climate services is marked by the World Meteorological Organization (WMO) in the report "The Global Climate 2001-2010, A Decade of Climate Extremes". In that regard, this

decade is the warmest since the start of modern measurements in 1850 and continues an extended period of pronounced global warming.

The ongoing Global Framework for Climate Services (GFCS) implementation will require complete support involving investment/funding necessary for institutional, procedural, infrastructural development as well as development of capacity building.

METEOROLOGICAL OBSERVING SYSTEM IN THE REPUBLIC OF NORTH MACEDONIA

Activities and results of the project

In the next period the Hydrometeorological Service should realize activities pursuant to five strategic priority areas of the World Meteorological Organization (WMO-Strategic Plan 2012-2015) and give its contribution to performing the Global Framework for Climate Services, capacity building of the service, performing the WMO Integrated Global Observing System (WIGOS), WMO Information System (WIS), and disaster risk reduction.

It is necessary to strengthen the capacities in the Hydrometeorological Service in order to realize all these activities as well as to establish the Global Framework for Climate Services through:

- providing the maintenance of quality meteorological observing system for the necessities of climate and its changes (variabilities, fluctuations and trends),
- development of the automatic meteorological stations (AMS) for upgrading of existing system on the base of unification of technical and software components, in accordance with the trends and recommendations by the World Meteorological Organization;
- installation of automatic meteorological stations at all main meteorological stations, climatological and precipitation stations in order to change gradually classical measurements with measurements of AMS;
- installation of AMS out of existing meteorological network
- establishment of special – more secure communication channels within the services of mobile telephony providers;
- establishment of laboratory for control, maintenance and calibration of meteorological instruments and AMS-sensors;
- providing 2 terrain vehicles for operative activities and maintenance of meteorological observing system
- maintenance and upgrading of climatological database CLIDATA
- digitalization of basic climatological data and information
- keeping and scanning of all historic meteorological and climatological data as a national wealth,
- usage of GIS-form at presentation of climatological conditions for various parameters,
- strengthening of computer (hardware and software) resources for use of regional climate models at preparation of seasonal forecasts for the territory of the Republic of Macedonia

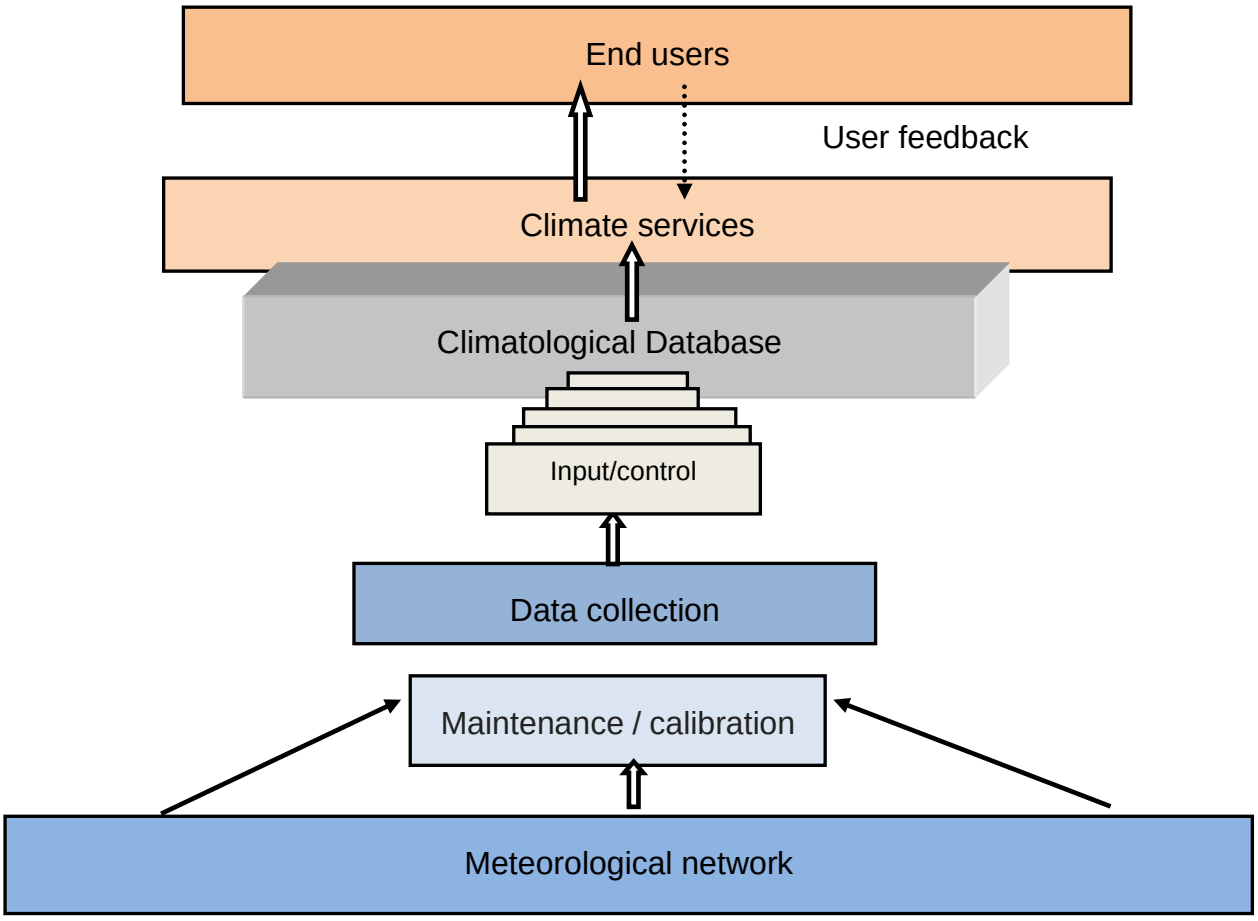
- education of staff in various areas
- urgent employment of professional staff (graduated meteorologists)
- payment of obligations arisen from the membership in WMO, EUMETNET and ECMWF in time

Within the organizational structure of the Hydrometeorological Service it is necessary to form a special unit for climate change which will be competent to monitor the climate changes, prepare climate forecasts and information and provide climate services for various users.

Strengthening of the capacities in the Service as responsible national institution for climate system monitoring in the Republic of Macedonia and providing the basic information on climate variability and climate changes are of the essential importance for the state and also the investigation of climate system vulnerability and repercussions which would affect different sectors (agriculture, forestry, water and water resources, health, biodiversity, tourism and the environment at all). The strengthening of the Service in this area is also significant for providing information of climate system condition and climate vulnerability not only at national, but also at regional and global levels.

Satisfying the basic prerequisites will enable the beginning of establishment of Climate services information system as a dynamic process of flow of various forms of climate services to the end users in order to influence their correct making of decisions which are vulnerable to climate conditions. Information exchange in such effective services system and correct and in time decisions should result with adequate socio-economic benefit in different user sectors.

CLIMATE SERVICES INFORMATION SYSTEM



Approximate sums of necessary financial resources for establishment and maintenance of Climate services information system are given in the following Table

	Description	Quantity	Amount in MKD	Total amount in MKD	Total amount in EUR
1	Automatization of meteorological observing system (purchase of automatic meteorological stations, installation, and networking in the existing system)				
	Main stations	8	1,200,000	9,600,000	155,794
	Climatological stations	15	600,000	9,000,000	146,056
	Precipitation stations	50	240,000	12,000,000	194,742
2	Terrain vehicles	2	1,000,000	2,000,000	32,457
3	Hardware and software			800,000	12,983
4	Equipment for meteorological sensor calibration			1,000,000	16,228
5	Spare sensors, instruments, and equipment			15,000,000	243,427
6	Equipment for meteorological data digitalization			620,000	10,062
7	Training for system maintenance			600,000	9,737
8	Unpredictable costs			1,500,000	24,343
	Total			**52,120,000**	**845,829**