

# Education and Training in a Period of Rapid Change: Highlights of the Fourteenth WMO Symposium on Education and Training (SYMET-14)

2022 edition

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WMO-No. 1291



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# CONTENTS

	<i>Page</i>
<b>FOREWORD</b> .....	<b>v</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>vi</b>
<b>INTRODUCTION</b> .....	<b>vii</b>
Background to SYMET-14 .....	vii
The importance of the SYMET-14 theme: Education and training in a period of rapid change .....	viii
Why rapid change is particularly challenging for education and training institutions ..	ix
<b>1. CHALLENGES FOR THE DELIVERY OF EDUCATION AND TRAINING ACTIVITIES</b> ...	<b>1</b>
1.1 Demand for new knowledge and skills created by evolving roles of National Meteorological and Hydrological Services and related operational services .....	1
1.1.1 Instruments and observations .....	1
1.1.2 Multi-hazard impact-based forecasts and warning services .....	1
1.1.3 Climate services .....	2
1.1.4 Hydrological services .....	2
1.1.5 Marine services .....	2
1.1.6 Technological improvements .....	3
1.2 Demand for technological changes in the delivery of education and training .	3
1.3 Demand for pedagogical changes in the delivery of education and training ..	4
1.4 Challenges in meeting these new demands .....	5
1.5 Unique challenges faced by developing countries .....	5
1.6 Keynote address by Dr Louis Uccellini, Permanent Representative of the United States of America with WMO .....	5
1.7 Keynote address by Prof. Dwikorita Karnawati, Permanent Representative of Indonesia with WMO .....	7
1.8 Keynote address by Acad. Markku Kulmala, University of Helsinki .....	8
1.9 Keynote address by Prof. Komi Sélom Klassou, University of Lomé, Former Prime Minister of Togo .....	10
<b>2. ADDRESSING CHALLENGES THROUGH INCREASED COLLABORATION AND COOPERATION</b> .....	<b>10</b>
2.1 Background to the WMO Global Campus initiative .....	10
2.2 Outcomes of WMO Global Campus panel discussion .....	12
<b>3. SUMMARY OF ADDITIONAL SYMET-14 ACTIVITIES LEADING TO ITS OUTCOMES</b> .	<b>14</b>
3.1 Thematic working groups .....	14
3.2 Regional working groups .....	16
3.3 Participant poster sessions .....	17
<b>4. THE WAY AHEAD</b> .....	<b>18</b>
4.1 Context of education and training in the WMO reform .....	19
4.2 Key current and future challenges .....	20
4.3 Policy makers and governments .....	20
4.4 WMO and other international organizations .....	21
4.5 The education and training community .....	21
<b>REFERENCES</b> .....	<b>22</b>
<b>APPENDIX A. STATEMENT OF THE FOURTEENTH WMO SYMPOSIUM ON EDUCATION AND TRAINING</b> .....	<b>23</b>
<b>APPENDIX B. THEMATIC WORKING GROUP INPUT TO THE SYMET-14 STATEMENT</b> ....	<b>28</b>
<b>APPENDIX C. REGIONAL WORKING GROUP INPUT TO THE SYMET-14 STATEMENT</b> ....	<b>44</b>

<b>APPENDIX D. INTERNATIONAL ADVISORY COMMITTEE FOR THE FOURTEENTH WMO SYMPOSIUM ON EDUCATION AND TRAINING (SYMET-14).....</b>	<b>59</b>
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## FOREWORD

It is a pleasure to provide the Foreword to the present publication documenting the outcomes and recommendations of the Fourteenth WMO Symposium on Education and Training (SYMET-14), *Education and Training in a Period of Rapid Change* (WMO-No. 1291). In 2018, the outcomes of SYMET-13 were published in *An International Agenda for Education and Training in Meteorology and Hydrology* (WMO-No. 1219). That publication documented the many challenges and opportunities facing the WMO Education and Training Programme (ETRP), including the large number of growing learning needs in new disciplinary and service delivery areas, as well as the need to support and enhance learning institutions to address them.

In the four years that have elapsed since SYMET-13, while significant progress has been made, challenges and opportunities have multiplied, and their pace has accelerated. There has never been a more exciting or challenging time for the weather, water and climate communities. Climate change demands new actions and approaches. Improved technologies and systems are allowing National Meteorological and Hydrological Services (NMHSs) to work more closely with their constituencies to offer impact-based services that directly communicate the likelihood of outcomes of weather and climate phenomena. The observations and data communities are making great strides in developing a global network that meets new expectations. Interdisciplinary approaches are required, and these are indeed being successfully developed and leading to new answers to the questions of scientific research and operational needs.

Ultimately, these many changes require both expanded and new approaches to offering learning opportunities. The input and output of SYMET-14 demonstrate that the ETRP is rising to challenges with innovations that will meet the growing needs, even in these times of financial constraints. The COVID-19 pandemic created further hurdles for WMO Members, but the community has responded with many successes, attributable, at least partly, to the willingness to come together in many venues, like SYMET, to share strategies and resources. Served by a network of WMO Regional Training Centres, national centres and many universities that meet the needs of WMO Members, the ETRP community is diverse, highly skilled and extremely dedicated. Each of these providers was well represented at SYMET-14.

The resulting recommendations contained in the symposium Statement should inspire effective continued and new action through the remainder of the current decade and beyond. I was pleased to read recommendations directed to policymakers and governments, to WMO and other international organizations, and to the education and training community as a whole, as well as general recommendations that express the urgency of propagating these results in order to further develop capacity into the future.

The present publication will be of great interest to the WMO community to demonstrate the many potential pathways to meeting learning needs for the ever-evolving services we provide to society.



Prof. Petteri Taalas  
Secretary-General

## **ACKNOWLEDGEMENTS**

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Members of the International Advisory Committee (IAC), including Co-Chairs Prof. Andrew Charlton-Perez and Dr Anna Timofeeva, offered substantial input to the organization and implementation of SYMET-14. In their capacity as reviewers, chairs and rapporteurs, they also contributed in many ways to the contents of the present publication. The full list of IAC members is provided in Appendix D.



## INTRODUCTION

### Background to SYMET-14

The Fourteenth WMO Symposium on Education and Training (SYMET-14) was held in virtual format for the first time, due to COVID-19 travel restrictions for many of the targeted participants. The organization of SYMET-14 was an important component of the WMO Education and Training (ETR) Office contribution to the [WMO Strategic Plan 2020–2023](#) (WMO-No. 1225) and [WMO Operating Plan \(2020–2023\)](#).

The symposium was attended by 280 registered participants from 65 WMO Members, representing developed, developing and least developed countries. All WMO official languages were represented and the gender ratio of participants was 53% female and 47% male. Participants actively engaged in the presentations and discussions, and over the four days developed conclusions and recommendations which are included in the symposium Statement and detailed further in this publication. Plenary sessions saw over 160 attendees at many times during the four-day event. Attendees of the opening ceremony were addressed by Professor Petteri Taalas (WMO Secretary-General), Dr Agnes Kijazi (Third Vice-President of WMO, Chair of the WMO Executive Council (EC) Capacity Development Panel) and Dr Yinka Adebayo (Director of the WMO ETR Office). The opening ceremony also included welcome comments from the opening day Chair, Professor Andrew Charlton-Perez.

In his welcome remarks, Professor Taalas emphasized the many changes that have been occurring within WMO, including significant governance reforms, with structural changes driven by a focus on the new WMO Earth system approach, rather than a collection of separate disciplines. He elaborated on the many new and developing WMO initiatives, including standards for a global basic observing network (GBON), a new data policy, and the Systematic Observations Financing Facility (SOFF) to support investment in these, as well as the growing data storage needs for the increased observations data. Professor Taalas highlighted the need to involve the private sector among WMO partners, noting the need for National Meteorological and Hydrological Services (NMHS) and academic partnerships as well. He noted many capacity development projects in which WMO is involved to improve early warning systems and climate services, as well as management training and advocacy support for NMHSs. He spoke on the important movement toward impact-based forecasting and multi-hazard early warning systems, including a joint centre on climate and disaster risk reduction (DRR) in partnership with UNDRR. Climate change and the need for improved climate forecasting and adaptation are additional critical drivers of change. The Secretary-General highlighted the importance of human resources capacity development for all actors in roles necessary to making these initiatives possible and to delivering quality services in keeping with these innovations (see sections 1.1 and 1.2 for additional details).

Professor Taalas thanked Members who offer education opportunities to those in need. He stressed the importance of SYMET as a coordination opportunity for WMO education and training providers. He also noted the need to adopt new, efficient delivery modes to meet the growing requirements for education and training. Finally, he thanked Dr Louis Uccellini for his many years of service to the WMO community, and for agreeing to offer a keynote address for SYMET-14.

In her welcome speech, Dr Kijazi focused on the important roles of the new EC Capacity Development Panel (CDP), which would be further elaborated upon during the week. She noted that SYMET-14 offered tremendous support for meeting the goals of the CDP, and that she looked forward to the SYMET-14 Statement as input to the CDPs work. She also noted the importance of the Meeting of Directors of WMO Regional Training Centres, which immediately followed SYMET-14.

In closing the welcome comments, Co-Chair, Professor Charlton-Perez noted that the rapid changes experienced recently have both presented significant challenges and inspired achievement of new innovations that present new opportunities.

The WMO education and training community, including regional centres, national training centres and universities, is tasked with improving the knowledge, skills and working methods of NMHS personnel to improve services globally. WMO Members have agreed to the courses of action to be taken, as elaborated in the [WMO Strategic Plan 2020–2023](#) (WMO-No. 1225). The aim of SYMET is to assist this community in working together to identify and address the challenges they currently face and will face in the coming years in implementing this plan.

### **The importance of the SYMET-14 theme: Education and training in a period of rapid change**

In 1970, a best-selling book entitled *Future Shock* (Toffler, 1970) discussed the impacts of rapid socioeconomic change on individuals, created by what it described as a transition to a post-industrial society. It noted that the accelerating rate of change at the time was causing feelings of disconnection and potentially extreme stress and disorientation. One of the features of the new society was labelled “Death of Permanence”, the title of Part One of Toffler’s work. Note that the date of publication was approximately 15 years before the first commercially viable personal computers, and 23 years before the first Internet web browser, yet the challenges of rapid change were already being recognized.

The extent of rapid change at the present time, however, is unprecedented. We live in a time that has been described as “liquid life”, in which change occurs more rapidly than new habits can be formed and old habits can be abandoned (Bauman, 2005). The outcome includes negative impacts, like those proposed by Toffler (1970), for many people. To avoid these disorienting impacts, liquid life calls for new responses to change and overcoming the desire for a high level of stability.

Due to the recognized difficulties of change in organizations, change management processes became popular in the 1960s to help organizations and institutions introduce changes. The Prosci [ADKAR model of change management](#) has proved one popular approach, but many others exist. However, today many people feel that the concept of change management itself is a victim of change, and that instead we need to embrace change as a persistent quality of life and must learn to live and operate within continuous change without distress (Worley and Mohrman, 2014).

Change management is a concept based on the desire to return to equilibrium after major adjustments to an organization, for whatever reasons they are imposed. But if indeed we have entered a time of liquid life, as Bauman (2005) proposes, there is no equilibrium to which to return. We need to learn how to function in disequilibrium. One clear answer is to better prepare people to be lifelong learners by offering them the skills to be solvers of complex problems (those with no clear right and wrong answers) and good seekers and critical users of information.

The nature of the rapid changes that WMO Members face arises from both positive and negative influences. The examples summarized below were treated in more depth during the four keynote presentations offered during SYMET-14. Please refer to sections 1.6–1.9 for summaries of these in the context of recent WMO EC and Congress decisions.

Some changes in operational and research-based Earth system sciences reflect positive evolution in related fields:

- Improved and standardized observations networks, especially through remote sensing, but also through more dense automated surface observations and innovative sources of data;
- Improved Numerical Weather Prediction models and methods that increase forecast accuracy at increasingly short ranges, as well as at seasonal ranges and in longer term projections;
- Increased understanding of Earth system science principles due to advances in research;

- Automation and artificial intelligence in forecast processes that allow increased time for NMHSs to communicate with customers and to customize products for specific customer sectors;
- New service delivery areas introduced or greatly expanded and improved, such as climate services and sector-specific services;
- Improved communication mechanisms for interacting with customers, including social networking and mobile devices;
- Improvements in operational strategies and increased cooperation with emergency response agencies before and during disasters that reduce loss of life relative to similar past events;
- Promotion of systems approaches to Earth sciences, in recognition of the high degree of interaction between traditionally distinct disciplines.

Other changes in the Earth system science disciplines result from negative influences:

- Global warming that increases the likelihood of extreme weather and climate events;
- Increased climate variability that makes traditional climatological expectations unreliable;
- Potentially increasing disruptions to societies and international relations due to competition for resources and to societal differences;
- Continued or increased disparity in the socioeconomic and technological development status of WMO Members;
- Unexpected impacts emerging from globalization, such as the health threats of the ongoing COVID-19 pandemic that began in early 2020.

Whether they originate from positive or negative sources of evolution, these changes create universal challenges in meeting societal expectations. The challenges of responding to change can be both cultural and practical.

While some people and cultures confront change more positively, many emphasize change as a threat to highly valued predictability. Some accept, or even embrace change and uncertainty, while others feel discomfort and avoid the uncertainty brought about by change. This dual response is both a cultural difference and an individual one (Hofstede and Hofstede, 2005). It reflects deeply rooted differences in our natures, differences which themselves create conflict due to potential misunderstanding and misinterpretation.

However, regardless of orientation, rapid change requires significant effort. Practical challenges to change include the need to invest in new resources, both technological and human, as well as the need for reorganization and process adaptations. New technological systems may be required, new expertise must be developed and new organizational structures might need to be considered.

### **Why rapid change is particularly challenging for education and training institutions**

Education and training institutions must be responsive to the changing needs of society. Yet this is not easy to accomplish when those needs are a rapidly moving target. Curricula revisions require careful attention, and usually place learning demands on those who will teach. They also require review cycles. However, these requirements are common to many design processes, and methods of rapid prototyping are now being applied in the design disciplines to help address the need for moving more quickly from conception, through design, to implementation, to meet customer expectations. Please refer to *Innovation processes in education* (Parrish, [Global Campus Innovations](#), Volume I) for a more detailed description of rapid prototyping processes. To cope

with curriculum revision challenges, some institutions have begun offering micro-degrees to help meet the need for continuing education in new specializations, which may lead to larger curriculum changes. Others are offering interdisciplinary degrees that draw from a blend of existing curricula.

Teaching, or knowledge construction in general, is inherently a cultural activity. Teaching is deeply embedded within its cultural context or contexts. Cultures arise from the shared values of a group of people who have geographical, racial, goal-oriented or other interpersonal commonalities. In other words, those who share a discipline also share a disciplinary culture. Because of this, the act of teaching is also the act of propagating a culture or cultures (Parrish and Linder-VanBerschot, 2010). Education and training institutions can be particularly resistant to change—resistance from students, educators and administrators alike—because cultural values are deeply held.

The changes to education and training are impacting not only what is taught, but who is qualified to teach it, the methods used for teaching, and the ways in which teachers themselves need to prepare to teach. The impact is multiplied in an international, multicultural context which has inherent potential for inequities in terms of preparation of learners and facilities for teaching. The shift to interdisciplinary learning may also create cross-cultural communication and participation challenges as well.

Many of the changes faced by WMO Members are on the scale of paradigm shifts, requiring deeply rooted habits to be discarded. This means that learning needs to occur not just in specific knowledge, but also in our understanding of the systems in which we are operating and learning. In addition, the systems themselves are undergoing changes to meet the demands of these paradigm shifts, which Gregory Bateson (1972/2000), an early systems theorist, refers to as Third-Level Learning, the highest form of learning that people and their social systems can undertake.

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## 1. **CHALLENGES FOR THE DELIVERY OF EDUCATION AND TRAINING ACTIVITIES**

### 1.1 **Demand for new knowledge and skills created by evolving roles of National Meteorological and Hydrological Services and related operational services**

#### 1.1.1 ***Instruments and observations***

In recent years, WMO has introduced several programmes and initiatives that reflect the evolution of technologies and scientific advances and will revolutionize the operational work of National Meteorological and Hydrological Services (NMHSs). In order to fully and globally operationalize these programmes and initiatives, significant training will be required. A number of these programmes and initiatives are highlighted below.

Improved instruments and metadata standards for observations networks require technical staff to modify their working methods. The WMO Integrated Global Observing System (WIGOS) Metadata standard ([Resolution 9 \(EC-73\)](#) – Plan for the WMO Integrated Global Observing System Initial Operational Phase (2020–2023)) entered its operational phase in 2020, requiring international compliance to better integrate all meteorological and climatological data. WIGOS includes the Global Observing System (GOS), the observing component of Global Atmospheric Watch (GAW), the WMO Hydrological Observing System (WHOS) (including the World Hydrological Cycle Observing System, WHYCOS), the observing component of Global Cryosphere Watch (GCW), and the co-sponsored Global Climate Observing System (GCOS). Newer supporting initiatives include the WMO Unified Policy for the International Exchange of Earth System Data ([Resolution 1 \(Cg-Ext\(2021\)\)](#) – WMO Unified Policy for the International Exchange of Earth System Data) and establishment of the Global Basic Observing Network (GBON) ([Resolution 2 \(Cg-Ext\(2021\)\)](#) – Amendments to the Technical Regulations related to the establishment of the Global Basic Observing Network), which will help to support the implementation and sustainability of the observing network, especially in developing countries, and particularly for surface-based, upper-air observations and automatic weather stations. In addition, a new WMO Basic Instructional Package for Meteorology Technicians (BIP-MT) will be introduced for approval in the course of 2022. The [Compendium of WMO Competency Frameworks](#) (WMO-No. 1209) includes four recently published competency frameworks on instrumentation, calibration, meteorological observations and observing programme and network management, which were approved to be included in the WMO Technical Regulations in 2018 ([Resolution 15 \(EC-70\)](#) – Amendments to Technical Regulations (WMO-No. 49), Volume I, Part V)). These new standards and frameworks are expected to be implemented by education and training institutions as soon as possible.

#### 1.1.2 ***Multi-hazard impact-based forecasts and warning services***

The [WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services](#) (WMO-No. 1150) (IBFWS), was recently updated with the addition of [Part II: Putting Multi-hazard IBFWS into Practice](#) (WMO-No. 1150), which distils and summarizes knowledge gained in the implementation of IBFWS globally, providing examples of good practices in IBFWS and illustrating and augmenting existing insights. The IBFWS innovation is perhaps the greatest paradigm shift NMHSs have faced in recent years, shifting from being scientific experts who only analyse, forecast and disseminate weather information, to becoming collaborating partners with users to communicate weather impacts to various public and private sectors. This change places a new emphasis on partnerships and communication, including risk and impacts communication, requiring new methods for analysis of potential impacts. While this practice has previously been in place in some larger NMHSs (some with specialized staff members dedicated to this role) and for specific sectors, such as aviation, it is now being promoted as the NMHS service delivery model expected of all WMO Members (see [The WMO Strategy for Service Delivery and its Implementation Plan](#) (WMO-No. 1129)). Additional time for NMHS staff members to assume these new responsibilities may become available due to increased accuracy in numerical weather prediction (NWP) forecasts, through improved modelling, increased data sources and data assimilation schemes, which may mitigate the increased demands. In addition, utilization of the Global Data-processing and

Forecasting System (GDPFS) of world, regional and national centres, can support efficient efforts in developing and communicating accurate, impact-based forecasts. The recently updated competency requirements for public weather service forecasters and advisers (see [Compendium of WMO Competency Frameworks](#) (WMO-No. 1209)) also highlight impact-based service delivery in the framework of personnel working in the development and delivery of meteorological and hydrological products and services, and the framework of public weather service advisers supporting disaster prevention and mitigation and other user activities.

### 1.1.3 **Climate services**

The Global Framework for Climate Services (GFCS) implementation plan was established by [Resolution 1 \(Cg-Ext\(2012\)\)](#) – Implementation Plan of the Global Framework for Climate Services. The GFCS defines the various areas that need to be addressed by NMHSs and other climate services entities, such as Regional Climate Centres, including agriculture and food security, disaster risk reduction, energy, health and water. Finally, in 2018, a WMO competency framework for provision of climate services was approved ([Resolution 15 \(EC-70\)](#) – Amendments to *Technical Regulations* (WMO-No. 49), Volume I, Part V). This establishes job responsibilities, performance criteria and expected learning outcomes that can guide training initiatives (see [Compendium of WMO Competency Frameworks](#) (WMO-No. 1209)). Climate services, as one of the newest service delivery areas, is perhaps the fastest growth area for education and training providers. A Basic Instructional Package for Climate Services is currently in development and will further guide capacity development efforts.

### 1.1.4 **Hydrological services**

The WMO Water Declaration and Water and Climate Coalition ([Resolution 6 \(Cg-Ext\(2021\)\)](#) – WMO Water Declaration and Water and Climate Coalition) highlights the growing importance of operational hydrology in addressing global water challenges and future opportunities in the broader WMO interdisciplinary context. The Vision and Strategy for Hydrology ([Resolution 4 \(Cg-Ext\(2021\)\)](#) – WMO Vision and Strategy for Hydrology and its associated Plan of Action) calls for: increased capacity development in hydrology and water management; the development of observation networks and data sharing consistent with [Resolution 1 \(Cg-Ext\(2021\)\)](#) – WMO Unified Policy for the International Exchange of Earth System Data; and increased use of the [Global Hydrometry Support Facility \(Hydrohub\)](#) to develop low-cost technologies and methods of observation and data processing. [Resolution 4 \(Cg-Ext\(2021\)\)](#) further promotes the development of the [Flash Flood Guidance System](#) with Global Coverage, as well as the more encompassing [Flood Forecasting Initiative](#).

### 1.1.5 **Marine services**

The WMO Marine Services Division is actively promoting training initiatives designed to address the WMO competency requirements framework for marine weather forecasters (see [Compendium of WMO Competency Frameworks](#) (WMO-No. 1209)), and to address the call for increased capacity development to strengthen marine and coastal services ([Resolution 29 \(Cg-18\)](#) – Strengthening marine and coastal services). Training was also designed to support implementation of a new [Guide to Marine Meteorological Services](#) (WMO-No. 471) and [Manual on Marine Meteorological Services](#) (WMO-No. 558). A global training initiative to improve marine service delivery is already underway, and new training to address the more technical marine forecasting competencies is required. Competency assessment guidance for Members is likely to be an output of the Standing Committee on Marine Meteorological and Oceanographic Services (SC-MMO), as well as promoting the development of additional competency frameworks. A [poster on the WMO Marine Services Course](#) was contributed to SYMET-14 through its poster session.

The examples above are critical, but just a sample of the service delivery areas in need of capacity development initiatives. The broad scope is evidenced by the large number of Guides, Manuals and other publications called for in [Resolution 81 \(Cg-18\)](#) – WMO Mandatory Publications

and Distribution Policy for the Eighteenth Financial Period. Several areas that are new or given new focus include integrated urban services (combining weather, hydrology and climate), atmospheric composition and air quality, and cryosphere monitoring.

#### 1.1.6 **Technological improvements**

While changing roles require new processes, technological changes also impact NMHSs and the way staff members carry out their work. For example, new and improved graphical forecast systems are used to display and analyse data products and produce forecast products. The ability to interpret advanced satellite products made available by new instruments on the latest generation satellites is a critical skill, although these satellite data are also critical to improved NWP. Using new Ensemble NWP products is yet another learning challenge. Many WMO Members are upgrading their observing systems and need to develop the skills to interpret the data they provide for local application. Utilizing and contributing to the GDPFS (*Manual on the Global Data-processing and Forecasting System* (WMO-No. 485)), mentioned above, which will make products and services operationally available to all NMHSs (products that might not have been available otherwise), will introduce opportunities for improvements, but also new learning demands. The GDPFS will offer high resolution NWP and other forecast products from World Meteorological Centres and Regional Specialized Meteorological Centres, while national centres might prepare and share forecasts and warnings at all forecasting ranges. The GDPFS will also carry out many coordination mechanisms to improve service delivery globally.

#### 1.2 **Demand for technological changes in the delivery of education and training**

Members were requested, via [Decision 2 \(EC-74\)](#) – Addressing the challenges related to the COVID-19 pandemic and mitigating its impacts, to pursue a flexible approach to meetings, including physical, hybrid and virtual meetings, aiming to maximize the participation of delegates and experts and to contain the carbon footprint of the Organization. This decision can also apply to learning opportunities, which have experienced disruption, but also led to several positive outcomes. At WMO Regional Training Centres alone, the number of training participants has more than doubled between 2016 and 2020, primarily due to the growth in distance learning delivery, both before and during the COVID-19 pandemic.

Due to the ongoing pandemic and the requirements for increased isolation from public spaces, most educators will immediately think of the need to implement online learning technologies as the primary change in how they provide education and training. But learning technologies have been innovating how classroom teaching takes place as well, not only, but including, the use of blended learning approaches, smart boards and course management systems.

Course management systems (such as the free Moodle platform), which become the virtual learning environments that serve as the “classrooms” in online learning offerings, are also heavily utilized in traditional classroom delivery modes. They offer user-friendly ways to share resources and links, to submit assignments, to increase interactions with fellow students and teachers through online forums and to manage assessment processes through the learning data analytics that the systems collect and display automatically for teachers.

Online conferencing systems, which have proved so valuable to organizations for maintaining their operations, have been used by virtual teams to enable international collaboration for many years, but they have also been a key technology that enhances online learning beyond the use of asynchronous approaches. Online conferencing allows not only audio and video to enable discussion, information sharing and demonstrations, but also computer screen sharing, text chat discussion, polling and question capabilities, and the potential to record live events for review or for those not attending. Nearly all conferencing systems also allow participants to share gestures to express approval, disapproval and lack of understanding, as well the practical gesture of a raised hand to ask a question.

Using such technologies implies developing not just new technical skills, but also new organizational and interpersonal skills—new ways of interacting with students require new ways of being a good teacher.

### 1.3 **Demand for pedagogical changes in the delivery of education and training**

Using new technologies, or new delivery methods like blended learning, does not in itself represent a pedagogical change. (However, various uses of blended learning in many incarnations do seem to stimulate innovative pedagogical approaches.) Pedagogies are strategies for determining which activities students should undertake and how learning should be assessed. Pedagogies are sometimes based on philosophical and cultural stances about how learning occurs, and sometimes based on research on learning, particularly cognitive psychological or sociological research, and are intended to improve the learning that occurs, no matter where it occurs—in the classroom, online or in a blend of these. Pedagogical approaches might call for increased activities involving discussion, inquiry or problem-solving, practical experience, cases or simulations, projects, practice and feedback, or lectures and readings. These can occur in all delivery modes in different ways.

The rapid changes occurring in our fields suggest several pedagogical approaches are important to achieve learning goals. While none of these are new, the changes described in the previous sections suggest that they deserve new emphasis.

The first of these is the demand for increased practical exercises, driven by the variety of workplace competencies being defined. To achieve competency-based outcomes, the skills to be learned require practice, assessment and feedback on their achievement. The background knowledge required to perform the skills is critical, but if learning and assessment stops there, it is not yet helping to develop competency. Competency-based learning calls for more emphasis on practical learning and less emphasis on pure information exchange. It calls for learning by doing. The more that learning activities resemble work tasks, the more they are likely to help develop practical skills. In other words, greater use of simulations, case studies and projects directly related to work tasks may be called upon.

Another important change, suggested in the Introduction, is the need to prepare students to become lifelong learners. This calls for making learners more responsible for their own learning, and less passive recipients of information. Practitioners who advocate for developing lifelong learning skills generally suggest the need for including tasks that call for independent and small group work, critical thinking and problem-solving, and innovation. The need to encourage metacognition about learning is also considered important, including asking students to reflect on what they learned by asking themselves what was difficult, what was most interesting, how they can use what was learned and how new learning relates to prior learning. Lifelong learning also calls upon learners to be goal-oriented and conscious of the time and tasks needed to meet their goals.

In times of rapid change, assessment becomes even more important. It needs to address not just what knowledge was acquired, but how this extends the skillsets of learners. For learning to be sustainable, assessment needs to focus on tasks that demonstrate that learning can be applied, not just recalled. To increase opportunities for feedback, formative assessment should be built into teaching, not left for a final (or summative) test of learning when it is too late for the teacher and learner to take corrective action. Opportunities for formative assessment are increased when learning is made more active through assignments and activities that call for application.

Finally, rapid change usually means there is more work and less time to devote to learning. In response, teaching needs to be either shorter and more targeted, or, when this is impossible due to the need to achieve larger learning goals, broken into sequences of smaller chunks that can fit into busy schedules. A secondary benefit of well-sequenced learning with smaller individual lessons is that it offers more opportunities for reflection, assessment and feedback. Another response to limited time is to build learning into work practices, to offer supportive environments for learning on the job, with coaching and other guidance provided.



#### 1.4 **Challenges in meeting these new demands**

Facing numerous demands for change is challenging. As mentioned in the Introduction, education and training institutions have deeply rooted cultures, so the first requirement is to overcome the desire to continue doing things as they have been done in the past. This applies to trying out new pedagogical approaches suited to skills development and shifting from being only an information provider to also being a skilful coach of practical activity and provider of feedback.

Another pervasive challenge is the time required to develop skills to use new instructional technologies. Teachers are often left to learn for themselves, which is not only harder but often disheartening. However, sharing the burden by learning in teams or creating opportunities to share among colleagues can be of help. (Collaboration as an aid in learning new tools and techniques was a common theme at SYMET-14.) Using new tools for teaching also requires time to choose those that are the best fit for the needs and the institution. Of course, the cost of making technological changes is financial as well. Budgets need to reflect this.

#### 1.5 **Unique challenges faced by developing countries**

In developing countries with limited resources, facing change offers even greater challenges. One primary challenge is that developing countries usually have fewer or smaller institutions that provide education and training. Obtaining it elsewhere is costly, and often requires travel away from family and the local context and culture.

Distance learning is an option, but it still has costs, especially for the developer and provider. It is also possible that learners in developing countries might not have experience with distance learning and can lack skills to be independent learners, which is required in quality distance learning experiences. Teachers may lack experience teaching at a distance as well.

One of the greatest barriers frequently mentioned is affordable and reliable Internet access. An unreliable electrical supply can also be a burden, as well as costly computer resources. While digital distance learning does not necessarily rely on high-speed synchronous Internet access, and can even be based on other more reliable media, including resources that can be downloaded at slow speed or sent on small media (such as thumb drives), synchronous Internet access is the predominant format for distance learning globally, due to its parallels to classroom learning. However, even older technologies like radio, augmented by print resources, are possible. When distance learning resources are designed for flexible use and accessibility, the challenges are at least mitigated.

#### 1.6 **Keynote address by Dr Louis Uccellini, Permanent Representative of the United States of America with WMO**

Dr Uccellini offered the first keynote address of SYMET-14, on the topic of *Preparing the Earth System Scientists of 2040*. He began by noting the movement away from pure meteorology to an Earth system science approach, which has become the basis of operational services that have come to realize that to serve customers in the face of multiple natural hazards, the focus must be on weather, water and climate linkages. He noted that it is necessary to go beyond forecasts and warnings and provide impact-based decision support services (IDSS) to key partners, such as emergency managers and water resource managers.

Dr Uccellini showed a slide noting the increase in extreme weather events in the USA alone, reaching 22 disasters in 2020 with losses exceeding US\$ 1 billion for each disaster, while the average over the previous 40 years was only 6.6 events per year, and 13.8 events per year for the last 5 years. These disasters result primarily from severe convective storms, wildfires, tropical cyclones, floods and droughts. While the slide addressed disasters in the USA, he noted that this increase is a global phenomenon.

The USA has adopted a cross-disciplinary initiative called Weather-Ready Nation that seeks to build community resilience, which involves daily interactions with community stakeholders, and not just government partners. This initiative has been extended to other countries by working with WMO on the Weather-Ready Nations initiative, which has had nine pilot programmes across the globe, particularly in the Caribbean and Central America.

The IDSS process is achieved by initiating interactions with stakeholders well before severe events, including through practice “table-top” exercises, to begin understanding needs and building trust and effective practices. IDSS is an end-to-end process starting with making observations data open, providing accurate and consistent forecasts and warnings, considering social science recommendations, but also finally focusing on working through government and local public and private partners, through multi-faceted communications mechanisms, to save lives and property. The IDSS process is an important addition to the jobs of those preparing weather, water and climate forecasts, and is considered necessary to achieve the mission of the National Weather Service in the USA (see Figure 1).



**Figure 1. The end-to-end IDSS process helps the NWS to realize its intrinsic value.**

Source: National Oceanic and Atmospheric Administration (NOAA)/NWS, International Activities Office

The NWS has noted differences between weather-based IDSS and water-based IDSS, especially in the longer recovery phase of flooding events. Similarly, urban IDSS is not the same as rural IDSS: due to different population densities and degrees of diversity, different communication challenges apply. Due to the benefits of longer lead times that allow for earlier evacuations, the communication of uncertainty becomes increasingly important.

The IDSS process is already showing successes in the form of more highly trusted forecasts to make the decisions to avoid unnecessary evacuations, and reducing deaths through earlier evaluations and preventative measures. Several success stories were shared about tropical cyclone events in the USA and the Caribbean. Winter blizzard success stories were also shared, such as the great reduction in ground traffic issues, which also aids road clean-up processes. Wildfire responses to IDSS have also led to earlier evacuations, by as many as several days, and more effective and focused firefighting.

Drawing on the case of the European floods of 2021 as one example, Dr Uccellini demonstrated that even with good flood warnings, the decision by local authorities to take necessary actions

can be a missing link. This experience reinforced the need for greater coordination and trust, and also highlighted the extreme nature of recent events that are surprising in their intensity. This intensification was further demonstrated by the 2021 New York City flooding, which was predicted in terms of total rainfall and included urban flash flood warnings. However, the extremely rapid rate of the rainfall, which reached, 3.15 inches in one hour in the city's Central Park, was not anticipated.

Dr Uccellini noted that social inequality can deepen impacts, for example, where there are decaying infrastructures or improper overuse of buildings. An equitable approach to intervention is required. To ensure this, the National Weather Service in the USA has worked directly with tribal nations, urban and rural poorer populations, Spanish-speaking communities, South-West Pacific island states and native Alaskan communities.

In his closing comments, Dr Uccellini noted that the IDSS concept has become so embedded in the services provided by the NWS that it is now included in the NWS mission statement. Achieving this mission begins with having a skilled, highly trained workforce. Some universities in the USA now offer joint meteorology/emergency management degrees to meet the interdisciplinary necessities of IDSS. The new emphasis on Earth system science approaches is creating new training needs, and new forecast frontiers also create new learning needs in areas such as hypoxia in bodies of water, health vectors, renewable energy, arctic environmental changes and space weather. The nature of operations also calls for an advanced Unified Forecast System modelling approach, increased IT and IT security, as well as engineers, and a new emphasis on the social sciences and humanities to round out service delivery needs. Special IDSS training has been introduced for every forecaster through 30 hours of distance learning, and those who will be deployed during extreme events require 90 hours of advance training. This includes immersive simulations with core partners and multiple components of the NWS. Training for climate and water hazard-specific IDSS is in development.

(A recording of this keynote address can be found at <https://vimeo.com/656032993>).

### 1.7 **Keynote address by Prof. Dwikorita Karnawati, Permanent Representative of Indonesia with WMO**

Prof. Karnawati spoke on the topic of *The Increasing Importance of Education and Training in Promoting the Paradigm Shift to Multi-Hazard Early Warning Systems (MHEWS) for NMHSs*. She began by highlighting the international threat of earthquakes, tsunamis and volcanoes, and how these recently increasing threats highlight the importance of the multi-hazard approach to issuing warnings. Each of these geological source events create many types of hazards similar to those of weather (flooding and landslides, for example). Tsunamis can also have meteorological origins during extreme events. These linkages demonstrate that education and training must be broadened for NMHSs, which are the primary link to the public for warning dissemination.

In addition, climate variability is a significant factor in creating hazardous conditions. Prof. Karnawati provided the example of the combined impacts of the El Niño-Southern Oscillation (ENSO) climate phenomena and the Indian Ocean Dipole mode, both seasonal events, on weather in the regions surrounding Indonesia, demonstrating the complex nature of anticipating severe weather events, and the need for both additional research and training.

Prof. Karnawati also referred to the publication *The Human Cost of Disasters: An Overview of the Last 20 Years, 2000–2019* (CRED and UNDRR, 2020), noting that the number of geophysical, hydrological, meteorological and climatological disasters reported from 2000–2019 has increased significantly. The *Sendai Framework for Disaster Risk Reduction 2015–2030* (UNDRR, 2015) offers a common process for disaster risk reduction to meet these increased occurrences, in terms of understanding risks, strengthening governance to manage risk, investing in risk reduction for resilience and enhancing disaster preparedness for response, recovery, rehabilitation and reconstruction. The framework has implications at all levels: global, regional, national and local.

These challenges require more robust and systematic observations and data, more systematic research and science-based decision support, more sophisticated technologies and more skilful

human resources, including observers, forecasters and modellers. However, socioeconomic diversity means that these actions alone will not create a safer society. NMHS partners and the public must be aware and understand the hazards and have the capacity for timely and appropriate response. This requires practical knowledge in how to use forecast products, and products that are designed with the end users in mind. Training needs to include more practical examples and more exercises, including case-based and problem-based learning opportunities. Systematic and continuous learning opportunities are required, and they must include interdisciplinary and intersectoral approaches, including collaborative learning opportunities involving both forecasters and their user sectors. Advocacy must be used to sustain government support for ongoing learning efforts, which, without promotion, can lull during periods with decreased or lesser impact events.

Prof. Karnawati closed by describing a learning and capacity development strategy entitled Case-based Practical Learning with Multi/Interdisciplinary and Pentahelix Approach by Applying Multimedia. The “Pentahelix Approach” means the involvement of not just operational forecast experts, but local and national government representatives, the community, the media and university experts. The entire end-to-end early warning process must be demonstrated in the case-based learning used. It is critical that all communities are aware of the severity of the potential impacts of natural disasters, and practical examples help to illustrate this. The presentation ended with an example of how a local fisherman with knowledge gained through training by the BMKG in Indonesia was able to save 120 citizens before an advancing tropical cyclone reached his village.

(A recording of this keynote address can be found at <https://vimeo.com/656033662>).

### 1.8 **Keynote address by Acad. Markku Kulmala, University of Helsinki**

Acad. Kulmala offered a keynote address on *A Look at the Future of International Meteorological and Hydrological Education*. He began by outlining the extensive challenges of natural disasters, and their consequences, including climate change, volcanoes, earthquakes, deteriorating air quality, increasing energy demands, biodiversity loss, difficult access to fresh water, ocean acidification, deforestation, insufficient food supplies, epidemic diseases and chemicalization.

Scientific diplomacy and interdisciplinary initiatives are needed in all continents. Many forms of data and information are required to provide the details, context and big picture of the current state of the environment, including ground-based data, satellite data and multiscale module outputs. Both a deeper understanding and practical solutions are needed; empirical measurements and modelling to move from observations to new theories are needed; as well as the ability to move from research to innovations to create economic growth and human well-being. Underlying this, improved knowledge transfer and seamless education and training opportunities will be required.

Current observations are still fragmented. Greenhouse gas, aerosol, air quality, ecosystem, weather and climate observations require an integrated approach to understand feedbacks, reduce uncertainties and to mitigate and adapt effectively. An understanding of how each element in the Earth system interacts is needed. To accomplish this, University of Helsinki has developed a number of SMEAR (Station for Measuring Ecosystem-Atmosphere Relations) stations which make observation of these interactions on a continuous, comprehensive basis by measuring over 1 200 variables influencing forest ecosystem and atmosphere interactions. Acad. Kulmala proposed that 1 000 or more such stations could be constructed across the globe in key ecosystems, including urban environments. WMO could offer leadership in such an initiative.

To better understand the state of the environment and how it functions, an integrated network of research institutions, a critical mass of interdisciplinary research, education and training, innovations, and science-society dialogue are needed. The Finnish Meteorological Institute’s (FMI) Institute for Atmospheric and Earth System Research (INAR) initiative brings together all these elements (see Figure 2).

## WMO: GLOBAL LEADERSHIP with CLEAR AND AMBITIOUS VISION



Figure 2. The comprehensive INAR Initiative of FMI, including the suggestion for global leadership by WMO

Source: Markku Kulmala

Quality education in the Earth system sciences of the future requires open data flows, well-educated data scientists, station networks for data collection, better models and increased connections to stakeholders and across disciplines. Education needs must be considered global, and across all age groups.

Barriers to information can include: lack of understanding of the extensive data needs; limited trust between stakeholders; limited understanding due to disciplinary differences; limited access to data, information and education; and limited discovery due to inadequate research capabilities as a result of upstream barriers. True interdisciplinary research in the Earth system sciences would include a research agenda that seeks to understand the relations of the atmospheric, aquatic and land systems, as well as anthropogenic activities and feedbacks and biogeochemical cycles across these systems.

The University of Helsinki organizes the Pan-Eurasian Experiment (PEEX) programme that has been active in developing several innovative projects on higher education approaches in collaboration with a number of institutions. One of these is highlighted in WMO *Global Campus Innovations*, Volume I, in an article entitled *Research-oriented Intensive Courses Foster Multidisciplinary Atmospheric Science* (Lauri et al., 2020). The University of Helsinki has also developed several Massive Open Online Courses (MOOC), which offer many freely available online learning resources, as well as for-credit options.

Acad. Kulmala closed by asking several open questions, including: What are the competencies needed to tackle climate change? How do they need to be taught? Who is a climate change expert? Why do atmospheric scientists hesitate in taking part in societal discussion? What kind of collaboration is needed for effective climate action? Education, and education partnerships, are key responses to these questions. WMO could take a leadership role in bringing about such education. Another key response to these questions is open educational practices: open data, open access and open educational platforms. The *International Universities Climate Alliance* is one example.

(A recording of this keynote address can be found at <https://vimeo.com/656034328>).

## 1.9 **Keynote address by Prof. Komi Sélom Klassou, University of Lomé, Former Prime Minister of Togo**

Prof. Klassou offered a presentation on *Preparing for the Rapid Changes Required in the Operations of Hydrological and Climate Services*. He began by outlining the background of climate change that is driving paradigm changes in how NMHSs do their work. Extreme events are increasing and are increasing hazards and creating greater damage. Rapid changes are required to improve strategies for planning and execution of operations in hydrological and climate services.

Over the last two decades, more than 75% of the population in West Africa have been affected by climate disasters once every two years, on average, including flooding, droughts, heatwaves and sandstorms. Data show that this is directly related to a clear increase in insolation and a resulting temperature increase. Data also show greater variability and irregularity of high and low precipitation events, creating difficulties for preparing a response. This demands increased responsiveness by NMHSs.

Quoting United Nations Secretary-General, Prof. Klassou noted that time is running out to address these increasing dangers, and that everyone must respond, not just NMHSs and scientists, but also the public. Prof. Klassou called for a paradigm shift in procedures that are multidisciplinary in nature. Each country needs to invest in addressing climate impacts, which are also socioeconomic and political in nature. However, developing countries are under-equipped to take the necessary actions.

Qualified staff who have received the necessary training and gained sufficient experience are lacking in developing countries, and in fact, decreasing (20% reduction in the last decade), which augments the gap between developing and developed countries. It is necessary to reconsider how training can address this gap, both at universities and specialized regional centres. An adequate and sustainable framework for education and training is required. SYMET-14 could create the impetus for this outcome by emphasizing the need for cooperation at the international level. Climate has no borders. Similarly, there should be an increase in knowledge sharing and education opportunities between nations and institutions.

Looking at the United Nations Sustainable Development Goals, climate change is cross-cutting and requires immediate action. However, the most recent Conference of the Parties (COP) shows only mixed results. Decisions of previous COPs have still not been enacted. Some solutions have been identified, but it is yet to be seen if they will be addressed. Countries still need to invest in the areas identified to meet goals. Cooperation is required in training and in the formation of regional centres of excellence that can serve as the focus of cooperation in research and development, as well as in improvement of operations and transfer of skills and knowledge.

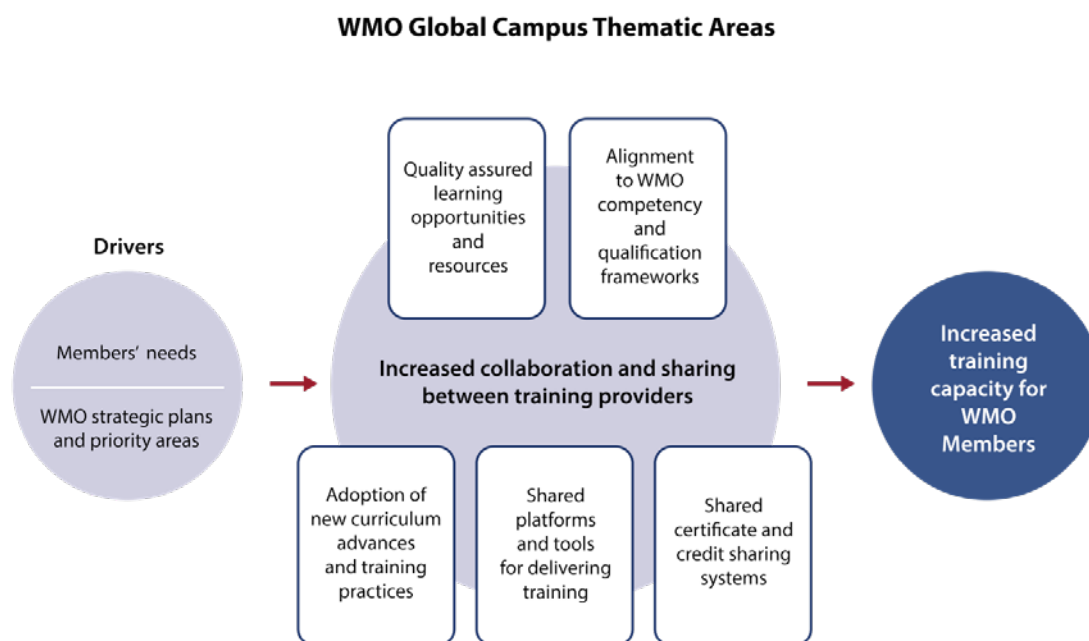
(A recording of this keynote address can be found at <https://vimeo.com/656034793>).

## 2. **ADDRESSING CHALLENGES THROUGH INCREASED COLLABORATION AND COOPERATION**

### 2.1 **Background to the WMO Global Campus initiative**

The WMO Global Campus initiative was founded on the principles of collaboration, cooperation and sharing in education and training. It is built upon the existing WMO Education and Training Programme, including the WMO Regional Training Centre network, national and international training partners, regional partnerships and allied communities. The initiative was approved by [Resolution 72 \(Cg-18\)](#) – The WMO Global Campus Initiative.

The WMO Global Campus is dedicated to increasing collaboration and sharing between training providers to increase training capacity for WMO Members through efforts such as those illustrated below (see Figure 3).



**Figure 3. WMO Global Campus thematic areas**

During the WMO Global Campus feasibility study period, several productive meetings were held to determine its potential. Several projects were also implemented. A Global Campus calendar was developed by the Caribbean Institute of Meteorology and Hydrology, in collaboration and in synchronization with other training calendars used by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and the WMO Coordination Group for Meteorological Satellites' (CGMS) Virtual Laboratory (VLab). In addition, a dedicated WMO Global Campus collection of training resources, organized by WMO competency frameworks, was implemented within the existing WMO E-Library. Going forward, a new training resources portal will be implemented for the Global Campus, which is expected to be launched in 2023. Finally, the COMET Translations Resource Center was developed (see [WMO Learn portal](#) under the "Collaborative Projects" tab > "Completed Projects"). All of these can be found through the [WMO Learn portal](#) on the WMO public website.

Two regional meetings of WMO Regional Training Centres (RTCs) were hosted to initiate greater regional collaborations. The first, for Spanish-language RTCs, was hosted in Lima, Peru and Santiago, Chile in 2018. The second, for Regional Association (RA) I RTCs, was hosted in Cairo, Egypt in 2019.

Two significant successes occurred prior to the WMO Global Campus discussions that took place at SYMET-14. In January 2021, a virtual meeting with over 200 participants, entitled *Addressing Challenges Beyond the New Normal: A WMO Global Campus Collaborative Webinar*, was hosted by the WMO Secretariat. The outcomes of that meeting reside at <https://etrp.wmo.int/course/view.php?id=201>, and will be the subject of a publication in 2022. In late 2020, the WMO *Global Campus Innovations* publication, in four volumes, collected nearly 50 papers on education and training innovations implemented by WMO Members.

While the ambitious goals of the WMO Global Campus have not all been fully implemented, all have seen progress and been discussed productively in different contexts. The discussion and action planning continued at SYMET-14.

## 2.2 Outcomes of WMO Global Campus panel discussion

The final activity on the first day of SYMET-14 was a panel and open discussion on the WMO Global Campus initiative, including proposals for carrying it forward into the future. Panel members included Prof. Andrew Charlton-Perez, Ms Marinés Campos, Dr Marina Baldi and Prof. Tinghuai Ma.

The panel noted many advances presented by the WMO Global Campus initiative. In the plenary discussion, many benefits, successes and opportunities were noted, but all come with requirements for additional efforts from many partners.

Among the benefits of the initiative that were noted were that:

- It places more emphasis on the importance of education and training than previously existed;
- It provides opportunities that benefit learners, trainers and also subject matter experts, and it can be of special benefit to WMO RTCs;
- It breaks down geographical, language, economic and subject matter barriers by connecting all stakeholders;
- It can be a mechanism to support interdisciplinary initiatives;
- It offers a space for communications between trainers as well as between experts and trainers;
- It has allowed for increased opportunities for collaboration with other training institutions;
- It has boosted the concept and practice of collaboration, which is a cornerstone of WMO;
- It aided opportunities to address the challenges of changing to online learning during the COVID-19 pandemic;
- The WMO Global Campus Events Calendar provides a window on to what is going on in other regions and other institutions, which helps to improve training offerings (as a benchmarking tool), and to better understand global training needs.

Among the successes mentioned were:

- WMO [Global Campus Innovations](#) was published in 2020, which introduced WMO training partners to new learning models;
- The [WMO Learn](#) portal offers access to learning resources, a learning events calendar and descriptions of innovative projects;
- Members have the ability to search for learning events by the competency framework or Basic Instructional Package they address, and the ability to subscribe to be notified of events of interest;
- The WMO Global Campus Events Calendar has increased international applications to courses advertised in that venue.

The opportunities and recommendations that were suggested included the following:

- Taking the next steps to support more education and training innovation in the rapidly changing environment is critical. Input from all partners is required to support innovation;
- A focus on collaboration, and not competition, is required, placing the emphasis on the challenges we all face;



- It is necessary to increase the visibility of the WMO Global Campus mechanisms to achieve more benefits;
- WMO Global Campus collaboration can help with the challenges in learning assessment and training evaluation faced by all;
- The initiative can help training institutions to implement WMO competency frameworks and find ways to offer common certification and credit-sharing systems, particularly for competency-based training;
- WMO Global Campus, in concert with the [WMO Strategic Plan 2020–2023](#) (WMO-No. 1225), can be a mechanism for helping institutions upgrade their training capabilities and expand their curricula;
- The Global Campus initiative can stimulate the formation of a new association of meteorological education and science, as well as support existing associations;
- A WMO Knowledge and Innovation Centre could be created to inspire and support innovations;
- Increased sharing of learning resources and improved access and searchability are needed;
- It is necessary to increase input to the WMO Global Campus Events Calendar;
- Efforts to increase resources for trainers should be made;
- There needs to be follow-up on the WMO [Global Campus Innovations](#) course and publication and continued innovation processes;
- Benefits can be gained by seeking to draw other communities into the WMO Global Campus initiative, particularly due to multidisciplinary needs (such as EOTEC DevNet, a network of networks on satellite skill applications, Earth system science contributors, Copernicus, social science community, community-based flood approaches by International Federation of the Red Cross, the partners involved in impact-based decision support, partnerships between universities and NMHSs to better understand partner communities and community needs, research institutions). The [International Universities Climate Alliance](#) also offers a good model and venue for collaboration;
- There is a need to give more visibility to the WMO Global Campus initiative and to enhance the [WMOLearn](#) portal, perhaps with bulletins;
- The [WMOLearn](#) portal usability needs improvement and needs to offer an alerts capability;
- The WMO courses for trainers should be used to expand the community;
- Users could benefit from the creation of a demonstration of the [WMOLearn](#) portal;
- A clear and transparent way to take part in the Global Campus community is needed, as well as any available support that can be sought;
- Mechanisms for offering and receiving training development and delivery support could be offered;
- There is a need for more sharing of experiences regarding instructional design, such as a virtual “room” to share new ideas;
- It is necessary to standardize how training is visibly linked to the WMO standards, such as the competency frameworks;
- It would be beneficial to have a place to post proposals for projects;

- The community would benefit from sharing more examples of international collaboration between experts;
- It would be beneficial to create a method for acknowledging service provided to the Global Campus;

It would be beneficial to consider ways to better link NMHSs and universities, as well as the private sector.

### 3. **SUMMARY OF ADDITIONAL SYMET-14 ACTIVITIES LEADING TO ITS OUTCOMES**

#### 3.1 **Thematic working groups**

During the plenary sessions on day two, SYMET-14 participants worked to develop recommendations based on nine themes identified by the International Advisory Committee, and then reported the outcomes of their discussions on day three. The recommendations each group made were then analysed before being incorporated into the SYMET Statement. The reported recommendations from the thematic working groups are collected in Appendix B. Also included in Appendix B is a summary of the background discussion that led to the resulting recommendations.

The SYMET-14 themes included:

**Theme 1:** Securing institutional commitment to share learning resources;

**Theme 2:** Newly proposed WMO Education and Training Board;

**Theme 3:** Micro-credentials and credit transfer: How could we proceed?;

**Theme 4:** Considering new pedagogical approaches and assessment methods, including the future uses of blended learning;

**Theme 5:** Technological barriers to online learning, and using partnerships between online education providers to overcome them;

**Theme 6:** Supporting the life cycle of professionals: from the decision to enter the discipline, to continuous learning, to maintaining job satisfaction and competency;

**Theme 7:** What are the content area expertise gaps within our academic teaching staff members? How do we identify and fill these?;

**Theme 8:** Update to the WMO Capacity Development Strategy;

**Theme 9:** How do we identify the critical regional needs for the professional development of operational staff? How do we ensure that appropriately qualified participants attend our training events?

Working group participants offered recommendations that at times overlapped, even if the groups were using different themes as starting points, which reveals the importance of those recommendations. Some of the more frequently offered recommendations addressed:

- Recognition of the need to develop new knowledge and skills for teachers in both NMHSs and universities, including particularly online learning methods (both live and self-directed), engaging and sustaining commitment of online learners, using blended learning, using new pedagogical approaches and new learning assessment methods;
- The importance of training impact evaluation;

- Recognition of the need to address scientific and technical skills gaps, many of which are increasing due to rapid changes in relevant disciplines;
- Recognition of the need for interdisciplinary education and training (including Earth system approaches), requiring greater interdisciplinary knowledge;
- Need for increased training in impact-based and multi-hazard forecasts and warnings;
- Need to increase NMHS and university collaborations for mutual benefit, including knowledge sharing and collaborative efforts, and ensuring workplace knowledge and skill needs are met;
- Recognition that the available time for training is limited, and efficient learning mechanisms need to be among the available options;
- Need to consider alternatives to traditional training, such as coaching and mentorships;
- Need for ongoing and more frequent curricula review, and recognition of workforce performance needs;
- Need to promote sharing resources and designing resources that facilitate adaptation;
- Need for an accessible and easy-to-use online platform for sharing resources, ideas and experiences, as well as physical media, when possible;
- Need for ongoing ways to share learning needs, expertise, review content and discuss education and training challenges and solutions, through CALMet and WMO Global Campus events, for example;
- Desire for mechanisms to promote collaborative creation of content and courses;
- More translation of resources and increased use of machine translation, which continues to improve;
- Methods for gaining greater commitment of WMO Members to the WMO Global Campus, and for providing recognition for service and contribution to the initiative;
- Ensuring quality standards for resources and courses shared through WMO Global Campus mechanisms, perhaps including training and content expert reviews, as well as user feedback;
- Use of micro-credentials, such as digital open badges, for finer granularity in the recognition of learning achievements, particularly related to competency frameworks;
- Need for promoting full usage of existing WMO Global Campus tools, and for the potential expansion of these;
- Recognition of regional and national differences, including technological barriers, financial resources for training and language differences;
- Establishing regional collaborations to mitigate inequalities in the training capacity of WMO Members;
- Need to address funding required to develop qualifications in disciplines represented by WMO;
- Need to retain competent staff members through lifelong learning and career enhancements;

- Consideration of how to utilize online learning in ways that avoid feelings of isolation, and recognition of other challenges of remote learning;
- Need for improved needs assessment methods;
- Need for increased assessment in the selection of training participants to ensure their readiness for learning.

### 3.2 **Regional working groups**

In addition to the thematic working groups, regional working groups met outside of plenary times to discuss the themes and particularly the need to make region-specific recommendations.

The following regional working groups met:

- Regional Working Group RA I, English;
- Regional Working Group RA I, French;
- Regional Working Group RA II, English;
- Regional Working Group RA III and IV, Spanish;
- Regional Working Group RA IV, English;
- Regional Working Group RA V, English;
- Regional Working Group RA VI and II, Russian;
- Regional Working Group RA VI, English.

Resulting recommendations overlapped greatly with the thematic working group outcomes, with several differences noted. Recommendations included:

- Increased and perhaps formalized, where they are not already, regional training partnerships and collaborative work;
- Investigation into the reasons why not all online learning that was implemented was successful in securing commitment from learners;
- Need for training in regionally-specific weather and climate phenomena and impacts;
- Desire for greater sharing of regional and national institution programmes and accomplishments;
- Creation of forums for interaction of regional alumni of training institutions;
- Establishment of regionally common credit systems for greater linkages of training received;
- Use of cloud technology for more diverse technical training;
- Need for competency framework toolkits for training and competency assessment;
- Desire to increase SYMET connection opportunities with more frequent brief meetings between the larger events;
- Request to WMO to expand the set of competency frameworks into new operational areas.

### 3.3 Participant poster sessions

In addition to the working groups, participants had the opportunity to contribute and review posters in three separate poster sessions of approximately 1.5 hours each during plenary break times. Thirty-one posters were submitted, representing 30 institutions (including five universities and nine NMHSs) and 22 countries. Poster themes focused on experiences with online learning during the COVID-19 pandemic, collaborative efforts for training development and delivery, innovative approaches to meeting new training needs, training evaluation and micro-credentials.

To encourage interaction, an online service provider, Virtual Poster Session, was utilized. This system hosted the posters and offered asynchronous discussion forums for questions and comments, as well as an option for live interactions with the poster authors, if pre-arranged.

To generate increased participation in the poster sessions, SYMET-14 participants were asked to vote for three posters they considered most valuable. A total of 52 participants voted, and five posters were identified as most appreciated through this vote. Below is a list of all posters, with winning posters indicated. Posters can be accessed at <https://etrp.wmo.int/course/view.php?id=220>.

- *Exploration and Practice of "Cloud Teaching" Mode on the Background of Coronavirus Pandemic Epidemic Prevention and Control.* Zou, L.; Yao, X.; Wang, Q; Suo, M.; Shi, Y.
- *Sharing the Knowledge on Oceans – WMO's Earth System Approach for Early Warning.* Venkatesan, R.; Thurston, S.
- **Second Place (shared)** *Action Learning: A Breakthrough to Bring Learning to the Workplace.* Nurhayati, N.; Adityawarman; Purwanti, R. Y; Prasetya, R.
- **Second Place (shared)** *Eumetcal's Approach to Fulfil our European Education and Training Needs.* ter Pelkwijk, H. (KNMI); Werder, F. (MeteoSwiss); Marekovic, T. (DHMZ); Ross-Lazarov, T. (COMET).
- *Remote Delivery of SWFP Training Workshops in 2021 – Experience and Lessons Learned.* Hussain, A.; Honoré, C.
- *World Climate Research Programme (WCRP) Academy.* Maharaj, A.; Lennard, C.; van der Wel, N.
- *Enhance Public Alerting for Emergencies Using the CAP Standard.* Christian, C.
- *Summary of the Online Phase Training on Numerical Weather Prediction at RTC Algeria for sub-Saharan Africa.* Bouzid, A.
- *Hydro-climatological Education and Training in sub-Saharan Africa: Prospects and Constraints.* Adeaga, O.
- *The Flipped Classroom Application in Vocational Training.* Hou, J.
- *New Approaches to Enhance Training in RIII and RIV (Spanish-speaking countries).* Doyle, M.; Campos, M.; Perez, M.
- *CALMet – A Valuable Network for the Worldwide Meteorological Education and Training Community.* ter Pelkwijk, H. (KNMI); Campos, M. (SMN); Nietosvaara, V. (EUMETSAT).
- **Second Place (shared)** *Reaction of the WMO RTC Network to the Required Rapid Changes in Education and Training.* Adiguzel, M. (WMO ETR Scientific Officer); Parrish, P. (independent researcher).
- *WMO Marine Services Course: Innovation, Keeping Pace with Rapid Changes.* Grimes, S.; Funaki, M.; Parrish, P.; Muller, B.; Kim, N.

- *Development of Education for Climate Enlightenment in Ukraine within the Framework of the EU ERASMUS+ Project of "Multilevel Local, Nation- and Regionwide Education and Training in Climate Services, Climate Change.* Zilitinkevich, S.; Stepanenko, S.; Aguilar, E.; Lappalainen, H.; Shablyi, O.; Khomenko, I.
- **First Place** *How to Break Ice in Online International Training.* Jinyang, C.; Yi, Z.
- *Work Together and Achieve More: NWP Blended Learning Training.* Fan, H.
- *Maintaining and Developing Competencies in Pandemic Times.* Hozoc, H.; Bugeac, P.
- *Online Courses in Meteorology and Climate at the University of Reading.* Weller, H.
- *Delivering and Evaluating International Synchronous Training Activities.* Page, E.; Bol, A.; Gram, W.; Kucera, P. A.
- *Making the Switch: Lessons Learned Moving Meteorologist Training Online at BMTC.* Pope, M.
- **Fifth Place** *Responding to a Pandemic – ECMWF's Move to Virtual Training.* Keeley, S.; Hemingway, B.; Stewart, C.
- *Development of Online Modules on Severe Wind Hazard and Risk Assessment for Tropical Cyclone Forecasters.* Lambrento, J. C. R.; Cinco, T. A.; Monteverde, M. C. A.; Estrebillo, L. J. D.; Dolendo, J. M. I.; Timbal, K. J.; Canlas, A. M.
- *Challenges and Opportunities in Training and Learning during the COVID-19 Pandemic: Flash Flood Guidance System (FFGS) with Global Coverage Example.* Mutic, P.; Dr Kim, H.
- *A Review of Meteorological International Online Training Held by CMATC.* Wenbin, J.
- *Remote Learning: A Challenge during Pandemics.* Bugeac, O. P.
- *Training and Retraining Hydrologists for the Hydrometeorological Service of Ukraine: Present State and New Challenges.* Manukalo, V.; Khilchevskiy, V.; Grebin, V.
- *Online Trainings in Climate-Oriented Education.* Mahura, A.; Ovcharuk, V.; Kryvomaz, T.; Lappalainen, H.; Lauri, K.; Khomenko, I.; Shablii, O.; Kabin, V.; Frankowicz, M.; Rashkevych, Y.; Sogacheva, L.; Zhou, P.; Mäkelä, A.; Krakovska, S.; Riuttanen, L.; Tyuryakov, S.; Bashmakova, I.
- *Education and Training Board.* WMO Education and Training Office.
- *Digital Open Badges: Micro-credentials for Learning Achievements.* Parrish, P. (Independent); Rapisardi, E. (CNR – IBE); Podgaiskii, E. (RSHU); Tarchiani, V. (CNR–IBE); Adiguzel, M. (WMO ETR).
- *Evaluating the Impacts of Training: Building on our Experiences and Supporting our Community.* Veeck, L.; Bourdelles, B.; Parrish, P.; Schroeter, D.; Bol, A.; Tarchiani, V.; Baldi, M.; Waongo, M.; Yeddes, L.

#### 4. THE WAY AHEAD

This section is a prelude to the SYMET-14 Statement, which can be found in Appendix A. It first describes the context of education and training within the reformed WMO structure, noting particularly its cross-cutting nature.

#### 4.1 **Context of education and training in the WMO reform**

The WMO mission statement indicates that “WMO works to facilitate worldwide cooperation in the design and delivery of meteorological services, foster the rapid exchange of meteorological information, advance the standardization of meteorological data, build cooperation between meteorological and hydrological services, encourage research and training in meteorology, and expand the use of meteorology to benefit other sectors such as aviation, shipping, agriculture and water management” (<https://public.wmo.int/en/about-us/vision-and-mission>). This demonstrates that education and training is fully embedded in the organization. Furthermore, the *WMO Strategic Plan 2020–2023* (WMO-No. 1225) states that WMO seeks the coordination of research and training in meteorology and related fields.

The key WMO governing bodies under the recent WMO reform include the World Meteorological Congress, which meets at least every four years and approves long-term plans and the budget for each four-year financial period. The Executive Council (EC) is elected by Congress and meets annually. It oversees the implementation of Congress decisions, manages the budget and acts on resolutions and recommendations from regional associations and technical commissions. Regional associations are responsible for the coordination of meteorological, hydrological and related activities, as well as training, in their respective regions. Technical commissions contribute to the development and implementation of globally coordinated and harmonized observations and service delivery to enable decision-making and realization of socioeconomic benefits by all user communities and by society as a whole. Technical commissions also have a responsibility to ensure that competency and capacity development opportunities are available to Members. The Research Board translates the strategic aims of WMO into overarching research priorities and ensures implementation of research programmes. Other bodies streamline the work of the organization and its decision-making. These include the Technical Coordination Committee, Policy Advisory Committee (PAC), Scientific Advisory Panel (SAP), Joint WMO-IOC Collaborative Board and several additional panels.

Each of these bodies has subcomponents to enable those with appropriate expertise to achieve the Strategic Plan. The EC is supported by a variety of panels, committees and task teams. Regional associations are supported by management groups, working groups and task teams. Technical commissions are supported by management groups, standing committees and expert teams. At the expert team level, new training initiatives and competency frameworks arise. Of course, training initiatives also arise from the education and training community as well. The workings of each body of the WMO are set out at <https://community.wmo.int/governance>.

In addition to the Education and Training Office, located within the Member Services Department, the WMO Secretariat includes technical departments, as well as regional offices located within the regions they serve. Regional offices, also within the Member Services Department, are the main point of contact between Members (in particular the Members' Permanent Representatives with WMO) and the Secretariat for capacity development aimed at enhancing infrastructure and services, supporting resource mobilization, building partnership and for advocacy-related activities.

Capacity development is a cross-cutting activity of the Secretariat, technical commissions and the Executive Council. WMO assists in the capacity development of National Meteorological and Hydrological Services (NMHSs) by developing and improving human resources as well as technical and institutional capacities and infrastructure, particularly in developing, least developed and small island developing States and Territories.

The range of WMO capacity development activities includes: support to countries for framing national legislation covering weather, water and climate activities through compliance with WMO Regulations; education and training; demonstration projects; regional support; research; development partnerships; and appropriate institutional arrangements. Regional Training Centres (RTCs) and WMO training partners play a key role in nearly all capacity development activities.

An Executive Council (EC) Capacity Development Panel (CDP) made up of Member experts, some from RTCs, works with the Secretariat departments through the Education and Training Office to support these broad efforts. The CDP also includes representatives from the technical commissions, the Research Board and key service delivery areas. The CDP monitors the priorities of, and activities under, the [WMO Strategic Plan 2020–2023](#) (WMO-No. 1225), the [WMO Capacity Development Strategy and Implementation Plan](#) (WMO-No. 1133) and the [WMO Gender Equality Policy](#) (2015), including institutional, infrastructural, procedural and human resources capacity development. The initial Terms of Reference of the EC CDP were established in [Resolution 7 \(EC-71\)](#) – Capacity Development Panel.

#### 4.2 **Key current and future challenges**

As described in the Introduction to the present document, the global Earth system science research and operations communities face a myriad of challenges as they move forward within the current climate of rapid change. A long list of these changes were offered in the Introduction, in Section 1.1 and in the keynote addresses.

Some changes reflect positive evolution:

- Improved and standardized observations networks;
- Improved Numerical Weather Prediction models;
- Increased understanding of Earth system science principles;
- Automation and artificial intelligence in forecast processes;
- New service delivery areas;
- Increased impetus for interacting with customers;
- Improvements in strategies for cooperation with emergency response agencies;
- Promotion of systems approaches to weather, water and climate services.

Other changes result from negative influences:

- Global warming that increases the likelihood of extreme weather and climate events;
- Increased climate variability;
- Potentially increasing disruptions to societies and political conflicts;
- Continued or increased disparity in socioeconomic status;
- Health threats from both weather and climate events and from rapidly spread pandemics.

The SYMET-14 Statement also contains open statements that note the sources of many of these changes, including many policy decisions.

#### 4.3 **Policy makers and governments**

The SYMET-14 Statement calls for governments and regional economic groupings to support the development of NMHSs with the range of services necessary for sustainable development and disaster risk reduction. It asks them to acknowledge the importance of initial and continuous professional development needed to develop the workforce ready to address the challenges of today and tomorrow. It asks for the promotion and sustainment of careers in meteorology, hydrology, climate science and related environmental disciplines.



#### 4.4 **WMO and other international organizations**

The SYMET-14 Statement asks for increased support by WMO and other international organizations to meet education and training needs in this time of rapid and increasing change. It calls for increased international partnerships between these organizations. The WMO Global Campus is identified as a key mechanism to support the collaboration necessary. The Statement supports a new Board of Education and Training Collaborating Partners, as well as expanding the competency requirements of education and training providers. To develop and sustain excellence in services, it calls for increased planning, communication, legal awareness, advocacy and financial and personnel management skills.

The Statement recognizes the importance of translations, localization of training, learning needs assessment, learning assessment, training evaluation and appropriate credentialing for development toward meeting WMO standards. It calls for continued and increased support for the WMO Global Campus initiative through a variety of mechanisms.

#### 4.5 **The education and training community**

Finally, the SYMET-14 Statement calls upon the education and training community to keep pace with the rapid changes in Earth system science and education and training practice. It notes the importance of cooperation to face the rapid changes ahead. One way is by contributing to the WMO Global Campus initiative.

Community institutions are encouraged to use online, blended learning and face-to-face modes, and to share expertise, resources and ideas for effectively meeting training needs.

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## **APPENDIX A. STATEMENT OF THE FOURTEENTH WMO SYMPOSIUM ON EDUCATION AND TRAINING**

### **Symposium Statement**

The participants of the Fourteenth WMO Symposium on Education and Training (SYMET-14), held online from 22 to 25 November 2021,

**Deliberating** on the theme "Education and Training in a Period of Rapid Change",

**Noting that** new advances in science, technology and meteorological, hydrological and climate services, along with the impacts of the COVID-19 pandemic, have accelerated changes in the content and delivery of meteorological, hydrological and climate training, leading to the need to develop new content areas, define new expected learning outcomes, offer new delivery modes and create new forms of instructional media and new pedagogical approaches,

**Noting also** the likely longevity and increasing pace of these changes,

**Noting further** the various international and national initiatives and commitments to address global issues related to natural disasters, environmental degradation, the Paris Agreement and the Glasgow Climate Pact, and the need for WMO to make significant contributions to the United Nations 2030 Agenda for Sustainable Development, the Small Island Developing States Accelerated Modalities of Action (SAMOA Pathway) and the Sendai Framework for Disaster Risk Reduction (UNDRR, 2015),

**Noting further** the decisions of the World Meteorological Congress at its eighteenth session (Cg-18) and at its extraordinary session in 2021 (Cg-Ext(2021)) on the WMO governance reform to embrace: a more comprehensive Earth system approach; the [Geneva Declaration – 2019: Building Community for Weather, Climate and Water Actions](#); other major initiatives and issues that are driving change within the WMO community, such as the new WMO data requirements; arrangements and policies for data exchange against the Earth system strategy as stipulated in [Resolution 1 \(Cg-Ext\(2021\)\) – WMO Unified Policy for the International Exchange of Earth System Data](#); the implementation of the Global Basic Observing Network (GBON); the shift to impact-based forecasts and warnings and multi-hazard early warning systems; the Global Framework for Climate Services; as well as the initiatives and issues that are driving change within the wider education and training sector of the global economy,

**Recalling** the agreed upon key areas requiring further development to enable the WMO education and training community to address the changing and increasing education and training requirements, both during SYMET-14 and SYMET-13, as well as previous WMO Global Campus meetings,

### **Expressed the following key observations and conclusions:**

- The world has recently experienced dramatic and rapid shifts in ways of living, interacting and educating, related to the COVID-19 pandemic. However, rapid change, driven by technological developments in particular, has been recognized as the new normal for many years, and in many more ways than those resulting from the pandemic. Teaching experiences during the COVID-19 pandemic have highlighted many innovative approaches to online and blended learning that could be more widely adopted. Studies of the success (or challenges) of these approaches provide the means of testing where and for what purpose such technologies might be deployed;
- Technological innovations and social evolution continue to change our lives and work; society expects greater accuracy in and increased usability of weather, water and climate predictions, including more openness in our sharing of data and forecasts; climate change has accelerated climate-related disasters, and extreme weather and water events are now

commonplace. Adapting to this change demands immediate action. At the same time, our workforce is becoming increasingly interdisciplinary, and accelerated progress in research and development uncovers new opportunities each year for service improvements;

- The WMO Executive Council (EC) Capacity Development Panel, established by [Resolution 7 \(EC-71\)](#) – Capacity Development Panel, is providing an effective means of driving forward innovation in capacity development;
- Cooperation between universities, National Meteorological and Hydrological Services (NMHS) training centres, WMO Regional Training Centres, the WMO-CGMS VLab, CALMet and international education and training partners provides a solid foundation for: increased sharing of teaching and learning resources and approaches; collaborating on development and delivery of education and training opportunities; developing model or common accreditation, certification, evaluation and assessment systems and their underlying quality control systems; and developing shared tools and platforms for developing, delivering and monitoring/reporting education and training activities;
- The decision to establish and promote the WMO Global Campus initiative helped education and training providers deal with changes to educational practice imposed by the pandemic and many proved to be successful. The WMO Global Campus virtual event on *Responding to Challenges Beyond the New Normal*, which took place from 20 to 22 January 2021, helped participants to outline the challenges that education and training providers are facing. It also served as a forum to exchange experience and propose some solutions that were successfully applied in many cases. Similarly, the WMO [Global Campus Innovations](#) publication, published in late 2020, highlighted many innovations in place prior to the impacts of the COVID-19 pandemic;
- Because the WMO education and training community works with students from many countries, language, gender and cultural awareness and diversity needs to be addressed across all activities;

### **Made the following recommendations:**

#### ***General recommendations***

- The WMO Secretariat is requested to play an active role in supporting and promoting the development and ongoing activities that comprise the WMO Global Campus initiative;
- SYMET-14 participants call for support and action at national, regional and global levels to support WMO and its NMHSs to develop and deliver improved services to the Members through the provision of adequate facilities and resources for education and training in weather, water, climate and related fields;
- SYMET-14 participants strongly endorse the benefits to themselves, their institutions and the community of coming together to discuss the future of education and training. In the future, holding interim meetings between symposia is likely to reap important benefits for the community and help to broaden it as Earth system science and prediction changes rapidly. This would also help in terms of monitoring the progress towards the recommendations in the present Statement;
- SYMET-14 participants further request WMO to publish the outputs of the present Symposium to enable widespread reference to, and use of, the key issues and recommendations;
- SYMET-14 participants call upon WMO, international development partners, authorities of countries and territories, and other stakeholders to take into account recommendations arising from this Symposium in their recurrent and development socioeconomic endeavours;

**To policy makers and governments**

- In order for NMHSs to provide the range of services required to address sustainable development and DRR goals, increased funding is required to support the initial and ongoing education and training of NMHS personnel and those entering the field. New models of funding for the education and training of meteorologists, climatologists, hydrologists and those in related environmental science disciplines, trainers in these fields and related technical staff including loans and work-study schemes are urgently needed in many countries;
- Governments and regional economic groupings to acknowledge the importance of increasing support for continuous professional development of meteorologists, hydrologists, climate scientists and those in related environmental science disciplines, as well as trainers in these fields and related technical staff members, as a result of rapid changes in these disciplines and advances in scientific research. Models of funding in which resources are shared regionally or internationally are likely to yield greatest benefit at highest efficiency. This includes funding for distance learning infrastructure – including Internet access for developing countries;
- Promotion of careers in meteorology, hydrology, climate science and related environmental science disciplines at all educational levels from early education to professional training schools is a high priority to attract the best students into our fields;
- To retain highly trained NMHS staff, training centre staff and university staff within the field, they need to be appropriately paid, rewarded and recognized for their contributions, particularly where their skill development makes them an attractive asset in other sectors;

**To WMO and other international organizations**

- The WMO Global Campus initiative is strongly endorsed as a mechanism to bring about and support existing international and regional collaboration needed to advance global Earth system science and prediction training needs. The concept should be broadened to include mentorship and peer-to-peer collaboration for the development of new resources and innovations;
- Noting international investment in Earth systems programmes around the world, and their significant training elements, WMO encourages relevant international programmes, such as the EU Copernicus programme and the Global Monitoring for Environment and Security and Africa (GMES & Africa) initiative of the European and African Union Commissions, to participate in the WMO Global Campus, with mutual benefits for all;
- A new, sustainable technological solution that allows the WMO Global Campus goals to be met should be developed and supported. Partner resources and support, as well as commercial off-the-shelf knowledge management platforms, might provide the facilities needed to share resources and ideas within the WMO Global Campus. Partnerships or sponsorship should be explored to facilitate this, as part of broader collaboration with the private and philanthropic sectors, which WMO is currently developing;
- The Board of Education and Training Collaborating Partners as a formal mechanism to achieve the goals of the WMO Global Campus initiative is also strongly endorsed;
- WMO to reconsider the competencies required of trainers to operate within a WMO Global Campus, which are broader than those traditionally acknowledged. There is a need to revise the *Guidelines for Trainers in Meteorological, Hydrological and Climate Services* (WMO-No. 1114) and the trainer competencies in the *Compendium of WMO Competency Frameworks* (WMO-No. 1209) to reflect the evolving needs of WMO;
- The evolving requirements of users, increasing regulation and the resource accountability by national governments and development partners require managers in NMHSs to possess

increased skills in planning, communication, legal awareness, advocacy, financial and personnel management and change management. Part of the remit of the WMO Education and Training Programme should be to help NMHS managers to develop these skills;

- New technologies have begun to break down language barriers that have traditionally prevented further sharing and cooperation. WMO is advised to seek and share guidance from other organizations on how best to take advantage of these new approaches;
- To ensure that learning needs are identified, the regular WMO training needs surveys and the Community Platform be used to seek community input;
- Gaining commitment from Members, institutions and individuals is vital to the success of the WMO Global Campus. WMO should explore awarding public credentials to institutions or individuals who fully contribute to the WMO Global Campus to a level proportional to their size and resources;
- The proposed Board of Education and Training Collaborating Partners to develop a pilot system to support the adoption of micro-credentials through the use of open badges and a mutual credit-sharing system that can be tested by a subset of institutions on a voluntary basis;
- Consideration of the local context for developing new training approaches should be paramount, including continued interaction between partners. This includes training in appropriate technologies, recognition of technological constraints and appropriate localization of case studies and examples. The proposed Board of Education and Training Collaborating Partners should produce guidelines for the community on ensuring that training approaches are appropriate for the local context;.
- Workshops that develop skills in learning assessment, competence assessment and training impact evaluation should be organized;
- It is important for partners to promote and aid the transition to training for impact-based forecasting and warnings and multi-hazard early warning systems, drawing on the excellent work already done in many countries;
- Ensure the WMO Capacity Development Strategy makes appropriate reference to education and training. This should be future looking and collaborative in nature to promote innovation in training development and delivery;
- It is recommended that partners work together to ensure that training initiatives are in compliance with the development strategies of those served and that the selection of training participants and beneficiaries is in alignment with the intended learning outcomes of the training;

### ***To the education and training community***

- It is recommended that the community review the continuing professional development needs of its staff in the light of the rapid changes in Earth system science and education and training practice;
- The community is encouraged to review its curricula in light of the new Basic Instruction Package for Meteorologists (BIP-M) and for Meteorological Technicians (BIP-MT) specifications and future basic instruction packages and competency frameworks. The emphasis on a broader range of skills for meteorologists, climatologists, hydrologists and those in related environmental science disciplines in the new BIP-M and BIP-MT specifications should encourage training institutions to consider the market need for new courses, including joint degrees, that link physical, social and technical science fields;
- The community is encouraged to advocate for greater cooperation wherever possible, particularly between NMHSs and universities. One important aspect of this collaboration

could be the offer of on-the-job training/work-based learning from universities, and requesting universities to add this element into their curricula where otherwise currently not available;

- The community is encouraged to commit the time of their staff to participating in the WMO Global Campus initiatives identified above, including the proposed Board of Education and Training Collaborating Partners. It should communicate this commitment to the ETR office, in return for the new recognition of its collaborating status;
- As part of this commitment, a set of institutions are invited to partner with WMO for the trial of micro-credentials and credit sharing;
- Community institutions are strongly encouraged to continue to develop and deliver training using online, blended learning and face-to-face modes, which would support reductions in the greenhouse gas emissions associated with training. Additionally, they are encouraged to explore new pedagogical approaches for teaching and assessment, embracing the new discoveries and skills acquired during the pandemic. As expertise, resources and ideas are developed, these should be shared through the WMO Global Campus and other collaboration mechanisms;
- Community institutions should develop mentoring schemes for staff at all levels, regardless of their job role. These initiatives are critical for retention of staff and ensuring equity for all people irrespective of nationality, gender, race or cultural background;
- Community institutions are encouraged to use open licenses, such as Creative Commons, that allow for reuse and derivation of shared resources, and to design resources that facilitate translation and adaptation.

SYMET-14 participants express appreciation to WMO for hosting SYMET-14 and for bringing together a broad group of institutions and experts to discuss the future of education and training during this particularly acute period of ongoing rapid change.

The present Statement was discussed and approved by the participants of SYMET-14 on 25 November 2021. Two hundred and eighty participants registered to attend SYMET-14, from which 253 attended live online sessions on the SYMET-14 programme. SYMET-14 participants represented 61 Members including from all WMO Regional Associations.

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## **APPENDIX B. THEMATIC WORKING GROUP INPUT TO THE SYMET-14 STATEMENT**

SYMET-14 participants worked to develop recommendations based on nine themes identified by the International Advisory Committee. The recommendations were then analysed before being incorporated into the SYMET Statement (Appendix A). The reported recommendations from the working groups that discussed each of these themes are collected in the present appendix.

The SYMET-14 themes were:

**Theme 1:** Securing institutional commitment to share learning resources;

**Theme 2:** Newly proposed WMO Education and Training Board;

**Theme 3:** Micro-credentials and credit transfer: How could we proceed?;

**Theme 4:** Considering new pedagogical approaches and assessment methods, including the future uses of blended learning;

**Theme 5:** Technological barriers to online learning, and using partnerships between online education providers to overcome them;

**Theme 6:** Supporting the life cycle of professionals: From the decision to enter the discipline, to continuous learning, to maintaining job satisfaction and competency;

**Theme 7:** What are the content area expertise gaps within our academic teaching staff members? How do we identify and fill these?;

**Theme 8:** Update to the WMO Capacity Development Strategy;

**Theme 9:** How do we identify the critical regional needs for the professional development of operational staff? How do we ensure that appropriately qualified participants attend our training events?

### **Theme 1: Securing institutional commitment to share learning resources**

#### ***Recommendation 1***

The working group recognizes that commercial off-the-shelf knowledge management platforms might provide the facilities needed to facilitate sharing of resources and ideas within the WMO Global Campus. We recommend that WMO explores partnerships or sponsorship with the private and philanthropic sectors, which might be motivated to support education and training as part of capacity development and climate change adaptation efforts, in order to facilitate provision of a platform for hosting resources, for aggregating resources on other platforms and for enabling collaboration.

Note. The working group is conscious that fast, reliable, Internet connectivity is not yet universal and that using alternative means to share resources and expertise (such as email and physical memory devices) is a reality for many Members. The needs of these Members should be explicitly considered in guidelines for resource design and review, and in platforms used to disseminate resources.

#### ***Recommendation 2***

There is an ongoing need to bring people together to share learning needs, share expertise, contribute to the reviewing and creation of content and to discuss matters related to education and training. The working group recommends that WMO facilitates and advertises wide access to commonly used fora/bulletin boards, signposting venues in which various conversations take



place. The working group further recommends that exemplar informal agreements (rules of engagement) for working collaboratively are produced to assist people to clarify expectations around issues such as contributions, ownership of intellectual property (IP), and so forth.

### **Recommendation 3**

The working group believes the competencies required of trainers to operate within the WMO Global Campus are broader than those traditionally acknowledged. These competencies now include working collaboratively and in partnerships; dealing with accessibility, IP and privacy issues; designing for ease of translation and localization; quality control and review of resources; managing online communities, and more. The working group recommends a review of the contents of the *Guidelines for Trainers in Meteorological, Hydrological and Climate Services* (WMO-No. 1114) and the trainer competencies in the *Compendium of WMO Competency Frameworks* (WMO-No. 1209) to reflect the evolving needs, believing this would send a stronger message than issuing a separate document.

### **Recommendation 4**

Translating resources into different languages and providing locally applicable case studies in learning resources is important for reasons of inclusivity and equity, and to enable better learning outcomes through connecting learning with concrete prior experiences. These two aspects are also important so that contributions written in languages other than the six official languages of the United Nations can be brought to a wider audience. The working group recommends that WMO should seek information on requirements for resources to be available in different languages as part of its regular survey of Members' needs, and through other feedback mechanisms. The working group further recommends that WMO should encourage Members to share and contribute to glossaries of technical terms, which facilitates translation, and to contribute examples of best practice in translation, including translation of live sessions and use of machine translation.

### **Recommendation 5**

Gaining commitment from Members, institutions and individuals is vital in the success of the WMO Global Campus. Being publicly recognized as being a valued Global Campus contributor is an important motivator for many institutions. The working group recommends that WMO should award credentials (badge/certificate/mention on website) to institutions or individuals who fully contribute to the WMO Global Campus at a level proportional to their size and resources. These contributions would include taking part in working groups, conferences, symposia, and so forth, as well as contributing quality resources and expertise, reviewing the contributions of others, and the curation, translation and localization of resources.

### **Recommendation 6**

Resources and expertise accessed through the WMO Global Campus must be trusted by users and other stakeholders as being authoritative and of a high standard. The working group recommends the establishment of a volunteer network of reviewers to assess contributions against agreed standards for good design, accessibility and academic integrity. Recognizing the importance of constructive feedback in the improvement of training, the working group further recommends that the WMO Global Campus platforms provide an opportunity for users to pass on both feedback and examples of the impact of resources to their creators. The combination of expert review and user feedback should be used to identify authoritative examples of resources on a particular topic, as well as subsidiary examples and case studies of more local relevance.

## **Background to the recommendations**

*Challenges or barriers to commitment (and to taking action):*

- Quality assurance: fear of judgement and lack of confidence;
- Incomplete knowledge of what is needed by others and of how to share;

- Intellectual property rules and attitude of sponsoring agencies;
- Languages and access to translation;
- Courses and resources are not designed to be reused;
- Existing fora for sharing work are difficult to navigate for some;
- Collaborating can be frustrating and hard to justify;
- Institutions' and individuals' motivation to share – what is in it for me?

## **Theme 2: Newly proposed WMO Education and Training Board**

### ***Recommendation 1***

Recognizing the value of the proposed WMO Board of Education and Training concept as a formal mechanism to promote increased collaboration under the aegis of the WMO Global Campus, the working group recommends further developing the concept and establishing this networking entity aimed at strengthening coordination and sustainability of education and training efforts in meteorology, hydrology and related environmental disciplines.

*Suggestions to consider regarding the present recommendation:*

1. When further developing the concept, the newly proposed entity should explore connections and benefit from existing mechanisms, networks and initiatives such as CALMet, the International Association of Meteorological Education and Sciences (IAMES), the network of WMO national focal points on education and training, and so forth;
2. The procedure for joining the entity needs to be further elaborated. The procedure could be drawn from existing practices of some networking entities, with an application form signed by the partner organization's director, outlining the expertise of the organization in education and training in meteorology, hydrology and/or related areas, and nominating the partner's focal point;
3. In terms of the composition of the entity's Management Group, seek a balance between representatives of the WMO-affiliated entities (including WMO RTCs) and actors from outside of the WMO domain;
4. The Management Group may request reconfirmation of engagement from its members after a four-year period;
5. Observation: There is a need to train the WMO Global Campus contributors on: using the (calendar and e-library) systems; the criteria for courses and materials to be listed; how to transform course advertisements into the WMO Global Campus descriptors; some features of the WMO Global Campus Events Calendar, such as alerts and subscriptions, which are not widely used.

## **Theme 3: Micro-credentials and credit transfer: How could we proceed?**

### ***Recommendation 1***

Acknowledging that **micro-credentials** are useful for demonstrating accomplishment of short or non-formal learning and can be **transferable and combinable** through credit transfer agreements, it is recommended that the WMO facilitate a collaborative initiative under the WMO Global Campus involving RTCs and contributing partners to adopt standardized micro-credentials for short and non-formal training.

**Recommendation 2**

Acknowledging that **digital open badges** are a free and open technical standard that can be used by any organization, it is recommended that WMO and partners define a minimum set of standard metadata for badges, and propose an open badges sharing platform (such as Badgr.io). RTCs and collaborating partners are invited to participate in the community of open badges under the WMO Global Campus and to adopt the minimum standard metadata for setting badges in their e-learning platforms.

**Recommendation 3**

Setting up a mechanism for evaluating the process of issuing and receiving badges, with some partners voluntarily adopting the open badges for some short-term training courses, as a pilot test, and providing feedback to the community, in order to evaluate the performance of the proposed solution.

**Background to the recommendations***Challenges:*

1. Accreditation of issuing institutions at both the national and international level is complicated and sensitive;
2. WMO is not an accrediting institution but can recognize institutions as RTCs or contributing partners;
3. Determining how to be sure that quality standards are respected;
4. Deciding who will set the technical standard to be adopted for micro-credentials;
5. Choosing a platform (free or paid) for sharing open badges;
6. Competency-based training: training courses (including micro-credentials) should refer to a common competency framework and course description, and should include a skills and knowledge framework. However, not all WMO competency frameworks are coherent or developed in the same way (for example, the competency framework for climate service providers does not yet have a defined skills and knowledge framework). Competency frameworks do not exist for all profiles.

*Opportunities:*

1. An existing network of institutions contributing to the WMO Global Campus;
2. RTCs are recognized by WMO, and the confirmation process ensures some quality standards;
3. Contributing partners with agreements with WMO can be also recognized;
4. Some experience in using micro-credentials and open badges;
5. Free platforms for open badges sharing exist: Badgr.io is an example which is already in use and interoperable with Moodle, Blackboard and other e-learning platforms;
6. Standards and competency frameworks are provided (or potentially provided) by WMO;
7. WMO could advise on the standard to be used by the community;
8. WMO could include this subject in the Training of Trainers courses.

*How can collaborative action contribute?*

1. RTCs and contributing partners can voluntarily test the use of micro-credentials and open badges, building on the experience of partners already using them;
2. A preliminary community of institutions recognized by WMO could start the process of testing the use of micro-credentials;
3. The community of WMO RTCs could be the starting point;
4. The preliminary community could be further enlarged with other contributing partners entering an agreement with WMO;
5. WMO and partners already using open badges can collaborate to define standards and provide some guidance, or advise on how to proceed (standard procedures and metadata for open badges);
6. At the RA I RTC WMO Global Campus Meeting in Cairo, December 2019, the AGRHYMET-RTC Niger, AEMET-RTC Spain, COMET and SAWS-RTC South Africa had expressed interest in participating as core testing partners in a preliminary test of the use of open badges, with the potential further participation of EAMAC-RTC Niger, WMO VLab CoE Morocco, IHFR-RTC Algeria and EMA-RTC Egypt.

*What steps might be required?*

1. Defining the community of RTCs and collaborating partners;
2. Proposing a basic standard (community identification, compulsory metadata, sharing platform);
3. Voluntary adoption of micro-credentials scheme by WMO Global Campus partners.

*Who is willing to take responsibility to contribute?*

1. As RTCs:
  - DOST-PAGASA-RTC Philippines;
  - AGRHYMET-RTC Niger;
  - CNR-IBE-RTC Italy.
2. As contributing partners:
  - University of Reading, United Kingdom of Great Britain and Northern Ireland;
  - ROSHYDROMET, Russian Federation;
  - ENM, France;
  - Check if AEMET-RTC Spain and COMET are willing to participate.

*What can contributors offer:*

1. WMO, CNR-IBE-RTC Italy and other experienced partners could suggest the basic standard for setting up the badges;
2. All: Set up badges in e-learning platforms (Moodle and Blackboard), adopt a common interoperable platform and provide feedback and lessons learned within a year.

## **Theme 4: Considering new pedagogical approaches and assessment methods, including the future uses of blended learning**

### ***Recommendation 1***

Provide guidance on training personnel and resources necessary for various sizes of training events. Additionally, encourage facilitation and collaboration among partners on how to help each other out.

### ***Recommendation 2***

Develop guidelines for facilitation and offer formal recognition by certification of personnel trained to apply the guidelines. This ties into the working group examining continuing professional development and micro-credentials.

### ***Recommendation 3***

Continue to strive to deliver online training, while not undermining the value of face-to-face training, but rather embracing new discoveries and skills acquired during the COVID-19 pandemic.

### ***Recommendation 4***

Arrange workshops to explore learning assessment and competence assessment and topics, and to evaluate impacts of training.

### ***Recommendation 5***

Create a formal WMO Global Campus Expert Team to take responsibility for promoting and sharing new pedagogical approaches, and to take on other actions as decided.

### ***Recommendation 6***

Provide continued support and promotion for CALMet as an important mechanism for sharing training innovations and new pedagogical approaches.

### ***Recommendation 7***

Expand the function of the global training calendars. Include, for example, regularly scheduled annual events as well as special workshops and conferences.

## **Background to the recommendations**

- The traditional pedagogical approach is “learning by knowledge transmission”. The value of “learning by doing” has been promoted in pedagogies for more than one hundred years. In recent decades, the value of this latter approach has led to new pedagogical approaches.
- Learning by doing forms the basis of competency-based training, as promoted by WMO, by offering practice and feedback in applying new knowledge and skills in job-related activities.
- New pedagogical approaches are based on the introduction of a variety of learning activities, such as:
  - Using the classroom for practice and feedback instead of information transfer (as in blended learning);
  - Assigning a project – problem/inquiry-based learning, for providing active and authentic contexts for developing knowledge and skills;

- Collaborative learning for students/participant groups to actively support one another in their learning;
- Case-based learning and simulations;
- Guided discussions;
- Other approaches.

*Goals/desired outcomes:*

- New and diverse pedagogical approaches are formulated/tested and adopted/further adapted/rejected for addressing the needs of diverse learners and to aid in developing complex knowledge and skills;
- Successfully tested pedagogical approaches are documented and shared with other education and training institutions;
- Traditional and culturally appropriate pedagogical approaches continue to be respected alongside new pedagogies;
- Both classroom and online learning delivery modes are combined and enhanced with active pedagogical approaches that help learners develop and practice targeted competencies and maximize learning opportunities;
- New forms of pre- (prior to and at the start of training), formative (during training) and summative (end of training) assessment are used that reinforce learning and confidently demonstrate achievement of targeted skills and knowledge outcomes;
- Elevate the word "pedagogy" to common usage. Promote pedagogy by defining what it means in simple terminology;
- From the existing framework, demonstrate various strategies to approach education and training to address the various audiences and levels of teachers/students/participants/experts for both traditional subjects (meteorology, hydrology, climate), cross-disciplinary subjects (social science, emergency management, others) and the general public;
- Perceived weaknesses in online learning assessment are mitigated by applying new strategies and technologies;
- To address diversity, equity, and inclusion: re-evaluate traditional assessment strategies in order to minimize poor performance;
- Encourage active learning in the workplace through peer-to-peer exchanges and mentoring;
- Encourage informal learning through participation in WMO VLab Regional Focus Group sessions.

*Challenges to address, barriers to action, tasks to complete, resources required:*

- What are the cultural and practical barriers that must be overcome by both teachers and students to adopt new pedagogical approaches? Barriers include language barriers, stereotype threat, inflexible curriculum and inflexible government regulations. Barriers that are more specific to the virtual environment include: reduced interaction between teachers and students; the extra time needed by teachers to implement the change from passive to active and from in-person to virtual learning; a potential preference of students for the passive classroom; and availability of technology and Internet connectivity;

- How should new pedagogical approaches useful to WMO education and training providers be identified, compiled and examples shared? As a start, trainers submit their favourite, least favourite and middle of the road approaches and an explanation of why. Then, interested members assess them to see what patterns emerge. Guidelines and examples from successful educational institutions can be included in various forms, such as models, infographics and video clips that are easy to understand. The current SYMET-14 offers great posters that have provided ideas for participants' own training management;
- How can increased institutional collaboration enhance awareness of and willingness to try new pedagogical approaches? Offer certificates from those institutes for the online courses that would have not been offered otherwise. Encourage peer-to-peer trainer and participant learning. Establish a community of members for interactions via an official social media platform, e-learning platform and e-library;
- What are the most compelling reasons to use classroom, online or blended learning delivery modes? Online education promotes self-learning by doing. It creates a new dimension of learning style that allows the learner to study anywhere, anytime. It works well in epidemic or emergency situations. In many instances, it saves costs and has no national border restrictions;
- What are the pedagogical approaches that are most conducive to skills development? There is a wide range of active methodologies: problem-based learning, project-based learning, learning capsules, case studies, flipped classes, workshops, reflective and inquiry-based learning, practice (both real-time and from simulations), exchanging and sharing experiences;
- How can formative assessment be used to maximize learning during training? Students are exposed to what to expect, teachers receive feedback on student prior knowledge and can adapt aspects of the lesson. As a teacher, evaluation is a process that does not end with the grade, but with the feedback to the student. To achieve a good evaluation experience, it is important to design adequate assessments and dedicate time to feedback;
- What are the summative assessment methods that produce the most valid indicators of various types of learning (such as background knowledge versus skills)? The diagnostic assessment is a very good instrument for evaluating the learning acquired, session by session. It motivates the learner to continually review their learning;
- How can online communication and interaction be enhanced for more effective and engaging learning experiences? Guided forums that invite collaboration, discussion and the transfer of experiences can be held. Ground rules for respectful engagement can be developed. AI can be used to help translate languages in order to increase confidence and reduce language restrictions. An opportunity to introduce oneself can be provided, particularly in small groups.

## **Group discussion**

### *Challenges:*

It may seem easier to continue teaching the way it has always been done, or the way teachers taught us. It is difficult to maintain motivation and contact with students throughout an online course, so that they feel welcomed and supported. For a programme looking to hire an instructional designer (and which has not done so before), what resources exist (such as job descriptions and instructional associations to tap into)? It is important to motivate current and future instructors to prepare themselves as educators. The new paradigm of teaching-learning which is centred on the student requires preparation in adequate methodologies; it is not enough just to be an academic expert. Obtaining administrative and financial support and finding extra planning time is another challenge. Students may also need preparation to be good online learners. One reference in this regard can be found at <https://etrp.wmo.int/mod/resource/view.php?id=8985>.

*Opportunities:*

The COVID-19 pandemic forced a move from the face-to-face classroom to the virtual classroom. Despite the difficulties, it opened up a new teaching-learning space, which has broken down borders and comes with new challenges and undeniable opportunities. There are countless examples and experiences, including:

- Utilizing existing resources from VLab, CALMet, WMO Training of Trainers, SYMET, education conferences such as the Online Educa Berlin, and those hosted by the European Distance and E-learning Network (EDEN) and the Association for Educational Communications and Technology (AECT);
- Encouraging RTCs to build a local knowledge library and share with the WMO Global Campus;
- Expanding the function of the WMO Global Campus Events Calendar, to include for example, regularly scheduled annual events as well as special workshops and conferences.

*Collaboration:*

Collaboration with trainers from other countries or institutions is important: 1) to make the training more relevant; 2) to attract new ideas and produce quality materials from diverse contributors with complementary skills; 3) to promote standardization in order to comply with competencies and recommendations; 4) to potentially save time – you will not have to wait a year for the expertise to be available, someone else from another country can contribute.

Fora can be generated where it is possible to exchange ideas about active methodologies and evaluation techniques, transfer experiences, generate support material, and so forth. Benefits can be realized from the existing collaboration between VLabs, RTCs, and so forth, in order to develop new online training courses and materials.

*Steps that might be required:*

To be able to collaborate, the following is needed: 1) virtual meetings; 2) a virtual space/resource depository to share drafts; 3) a list of persons/trainers and areas of expertise (such as instructional design, IT assistance and others). External teachers/trainers can be invited to courses and sessions as observers to provide examples of and assist in transferring teaching skills.

*Institutions willing to take responsibility to contribute, and contributions they can offer:*

Could a volunteer WMO Global Campus Task Team be formed to take responsibility for promoting and sharing new pedagogical approaches?

The WMO ETR Office plans to investigate new tools to support the sharing of open educational resources within the Global Campus.

SMN-RTC Argentina (which comprises the national meteorological service and two universities) is eager to contribute resources and trainers, especially in the Spanish and English languages.

**Theme 5: Technological barriers to online learning, and using partnerships between online education providers to overcome them**

***Recommendation 1***

Recognize that each region will have experience of different technological barriers and need appropriate tools to overcome them.



**Recommendation 2**

Recognize that each country needs to invest in training, but resources required for online training can be a barrier. Every region/area needs access to its own set of properly working tools. The working group notes that many free tools impose limitations on functionality.

The working group highlights the EUMETCAL model of funding to pool resources to give everyone access to greater resources (tools and training material) when working together. This could be modelled at a regional level with tools and training (including training of trainers) in the appropriate context for the technology available.

**Recommendation 3**

Re-think how teaching is delivered online/remotely. A new framework is needed for delivering training in an online/remote manner. For example, very poor and/or expensive Internet connections makes it very hard to reach and engage participants. The technology used to undertake training may vary widely (mobile phone, computer, and so forth).

It is necessary to:

- Make optimal use of online training opportunities (when available);
- Develop training resources that are independent of time and place and can be taken home to study (see, for example, Republic of Korea SSD delivery of numerical weather prediction (NWP) training);
- Train trainers to create, deliver and assess courses in the context of their particular regional situation. This is desperately needed.

**Recommendation 4**

Investigate how to reuse and formulate material so that it can be translated into the learner's native language. Make use of new AI tools becoming available.

**Recommendation 5**

Training on the use of technological tools must not be overlooked. It is important that all technology used is aiding learning rather than frustrating the learning experience for the trainer/learner.

*Suggested actions:*

- Training support to help those starting to deliver training;
- Sharing of best practice and what has worked well (for example, at CALMet meetings);
- Collaboration and sharing of resources (each partner offers different expertise, infrastructure, funding and content) (EUMETCAL is an example of this);
- Encourage/empower those who are starting out with delivering online learning to develop skills and so forth, by partnering with those who have more experience (would it be possible to look at World Bank funding?).

## **Theme 6: Supporting the life cycle of professionals: From the decision to enter the discipline, to continuous learning, to maintaining job satisfaction and competency**

### **Recommendation 1**

For attracting learners to meteorology:

- (a) NMHS, education and training provider and WMO publications should promote the importance and attractiveness of careers in meteorology and related disciplines. This needs to be expanded to include documentation that is used on social networks, as this is the medium that new recruits use the most;
- (b) Funding opportunities to study meteorology are suggested in countries where universities charge for training. The funding is linked to work placements that are required in order to pay back the funding. These opportunities are usually advertised on special forums, although social networks can also be used.

### **Recommendation 2**

For entry-level professional development:

- (a) Mentorship will be critical for the development of new personnel within an NMHS, as this will settle the new recruit and achieve faster growth and results;
- (b) Formal further development should also be encouraged.

### **Recommendation 3**

For retention strategies in the context of general lack of monetary funds:

- (a) NMHS staff members need to be appropriately rewarded and recognized for their contributions;
- (b) In the absence of growth due to administrative policies, it is suggested that dual career options (which equally combine administrative and scientific career options) and policies are explored, to ensure that the scientific personnel are looked after;
- (c) Ample professional development options need to be explored, such as funded part-time studies (with time allocated to the studies), targeted short courses, conferences, symposia, and so forth. Options could also include alternative and affordable pathways to education, such as credit sharing and collaborative degree programmes;
- (d) Opportunities to change policy to enhance careers, such as attributing full public service status to entities, should be investigated, so that the retention of staff can become an option;
- (e) Enhancement of careers, that include exposure either publicly or professionally, such as consultancy work or international exposure on working groups, and so forth;
- (f) Enhancement of scientific opportunities, such as expansion of available instrumentation or computers equipment, or enhanced tools of the trade.

## **Background to the recommendations**

*Challenges to address:*

- (a) Entry into meteorology: the requirement of mathematics and science does limit the people that can enter the field of meteorology. Furthermore, these subjects are the same as required to enter the medical and engineering fields. (In French-speaking countries, meteorologists are called engineers, which might actually alleviate the problem);

- (b) The training of entry-level meteorologists (including forecasters) is critical, so that they can function upon entry into a job;
- (c) The retention of experienced meteorologists is now becoming critical, especially with the great resignation that is taking place after the COVID-19 experience, when people became more aware of what they want from their jobs.

*Barriers to action:*

- (a) In certain counties there is a shortage of learners that qualify with the mathematics and physical science required for meteorology;
- (b) If guidance is not given to entry-level meteorologists, they will become frustrated and leave the profession;
- (c) Most of the time, money is not available for the retention of experienced scientists/forecasters, and other options need to be investigated. This was especially the case during the COVID-19 pandemic, due to funding/commercial revenue shortfalls.

**Theme 7: What are the content area expertise gaps within our academic teaching staff members? How do we identify and fill these?**

***Recommendation 1***

WMO should identify current and future skills gaps within the training workforce and determine how the needs vary between regions. An extensive survey, which is not restricted to WMO Members and NMHSs, should be conducted.

***Recommendation 2***

Continuing professional development for the meteorological and hydrological training workforce should be encouraged in the following critical scientific areas: Earth system science, impact-based forecasting, interpreting forecasts (particularly ensembles), data science and dealing with big data, machine learning, artificial intelligence, causal thinking, geographic information system (GIS) and the application of real-time Earth observations to fields beyond weather prediction (such as disaster management). Furthermore, continuing professional development in the following non-physical science skill areas (“soft skills”) is also encouraged: science communication, forecast communication, risk assessment and management, and disaster management.

***Recommendation 3***

WMO should promote and aid the transition towards impact-based forecasting. This requires a change in mindset in trainers and particularly academic staff away from “what will the weather be” to “what impact will the weather have”. WMO should promote relevant existing publications and resources beyond NMHSs and draw inspiration from the United States National Weather Services “Weather-Ready Nation” programme and its ambassadors.

***Recommendation 4***

WMO should increase the visibility of the WMO Global Campus and expand the courses and topics covered. “Train the trainer” courses should be included and promoted outside of NMHSs/ RTCs. The language of the training should be carefully considered. Interdisciplinary courses should be included and stronger alliances with closely related fields (such as Earth observation) should be promoted. WMO should actively advertise how trainers and academic staff can contribute to and actively participate in the WMO Global Campus.

### **Recommendation 5**

Curricula should be frequently reviewed and adapted flexibly to meet rapidly changing demands. Universities should actively collaborate with NMHSs and other employers of meteorologists and hydrologists when reviewing and developing curricula and degree programmes. It was noted that currently there can be a mismatch between what universities teach and what skills NMHSs require. It was further noted that it can take time for universities to change, so careful forward planning is required. WMO should provide universities with clear guidelines on anticipated education needs in the next five years.

### **Recommendation 6**

WMO should encourage universities to develop joint degrees between physical science fields (meteorology, hydrology) and both social sciences (such as communication and journalism) and more technical fields (such as data science and machine learning). Universities should incorporate soft skills (scientific writing, science communication, research planning) into their single-subject degrees. WMO should provide clear guidance on the most relevant additional skills and should encourage universities and training centres to consider future training needs during the recruitment of staff.

### **Recommendation 7**

WMO should promote and aid collaborations between academic staff in traditional fields with those in complementary fields. WMO should acknowledge that the current meteorological and hydrological training workforce will not be able to teach all skills required in the future and that collaboration is essential. Furthermore, WMO should acknowledge that the meteorology education and training community needs to evolve to become more diverse and interdisciplinary in the near future.

### **Recommendation 8**

WMO should acknowledge that increasing the skill level of trainers and academic staff (as well as the skill level of those they educate) makes these individuals highly employable outside of our field. WMO should ensure that the highly skilled workforce can be retained within the meteorology and hydrology field.

### **Recommendation 9**

WMO should acknowledge that academic staff and trainers lack time to develop new skills and are often required to teach a topic in which they are not an expert. WMO should require trainers and academic staff to meet basic competencies and should provide flexible training courses, for example Massive Open Online Courses (MOOCs), to ensure this can happen.

### **Recommendation 10**

WMO and its Members should be aware of potential, future challenges resulting from the COVID-19 pandemic and the enforced sudden change to online training. Students whose education and training was disrupted may lack certain subject-specific skills or competencies. Furthermore, such students and learners may lack social skills, team-working skills and personal interactions skills as a consequence of studying alone and/or remotely for an extended period of time.

#### *Goals/desired outcomes:*

- That the myriad of challenges imposed, and the new knowledge and skill requirements created by rapid changes in scientific methods and operational requirements, are met for both learners and the education and training staff who teach them;
- That institutional systems and policies are in place that help to address the ongoing requirements to respond to such fundamental changes to educational requirements;

- That WMO Members work together to ensure that gaps in opportunities for capacity development in these growing new areas are minimized.

### **Theme 8: Update to the WMO Capacity Development Strategy**

#### **Recommendation 1**

Make the WMO Capacity Development Strategy more robust in how it pertains to education and training.

#### **Recommendation 2**

Seek input from RTCs, universities and Members in order to document the challenges, needs and roles and responsibilities in capacity development.

#### **Recommendation 3**

Ensure the Capacity Development Strategy (CDS) be future looking and collaborative in nature to promote innovation in training development and delivery.

#### **Recommendation 4**

Emphasize the need to be inclusive of the numerous languages of the world. Seek professional translators for the six official United Nations languages and make translations freely available to the RTCs.

#### *Background to the theme:*

- WMO Capacity Development cross-cuts nearly every activity and programme within the organization. The WMO Education and Training Office provides critical services to aid in developing capacity within NMHSs.
- The current [WMO Capacity Development Strategy and Implementation Plan](#) (WMO-No. 1133) was last written in 2015 and is out of date. Significant changes to WMO governance, in the context of an evolving world, necessitates an update to the strategy.
- A Task Team within the EC Capacity Development Panel has written a draft of the new CDS and has requested feedback and suggestions from the education and training community to ensure it is relevant and accurate in its future world.

#### *Challenges:*

- Reinvention of the same training topics;
- Sorting through the numerous training opportunities and programmes for NMHSs;
- Limited time for training;
- Technological requirements;
- Financial constraints;
- Emerging technologies and weather services (impact-based decision support services (IDSS), Space Weather, climate).

#### *Needs and potential solutions:*

- Collaborative methods of training development and delivery to reduce repetitive development of similar training materials;

- Innovative and cost-saving technologies for virtual training delivery;
- Build on the lessons learned from the COVID-19 pandemic and do not to go back to the way it was;
- Develop effective online/virtual training programmes that combine the positive aspects of distance learning with local hands-on training;
- Find a balance between distance learning and face-to-face or hands-on training, that is, blended learning solutions;
- Seek out solutions for language translation of training materials.

*Role of WMO:*

- To enable opportunities for collaboration and sharing and to help link local and regional needs and institutions to provide solutions;
- To provide the “global view” and to identify best practices and issues that NMHSs are facing.

**Theme 9: How do we identify the critical regional needs for the professional development of operational staff? How do we ensure that appropriately qualified participants attend our training events?**

***Recommendation 1***

When planning education and training activities, it is necessary to address critical regional needs identified through best practices shared by WMO Members and through WMO governance structures and the WMO Community Platform.

***Recommendation 2***

WMO RTCs and partner education and training institutions should introduce assessment procedures for ensuring that the choice of training participants is in compliance with the development strategies of Members served. Member institutions require support in identifying the most valid assessment methods.

**Background to the recommendations**

*Recommendation 1: Identifying critical regional needs:*

- The need for two-directional communication between Members and WMO/RTCs and affiliated institutions is critical;
- A shift in the Members’ paradigm on assessment;
- Proposal: change the emphasis from training needs to identifying opportunities for development for career progression;
- Increase the human capacity of Members/RTCs/WMO to effectively identify opportunities for development;
- Proposal: in the future, WMO could deliver an Assessment Training Course (similar to the previous Train the Trainer courses) including technical aspects of assessment;
- Assessment communication skills.

*Recommendation 2: Ensuring that appropriately qualified participants attend training events:*

To help ensure that students have the maximum opportunity for success in completing a course/programme, the following recommendation are made (where appropriate):

- For advanced courses, the use of pre-tests or courses as a prerequisite to registering for a course;
- Use of a blended learning course approach to a course/programme where the completion of the first part will allow the student to progress to the next portion of the course;
- It was also noted that undertaking the above actions would be informative in identifying additional opportunities for development within the region.

*Additional outcomes:*

- Members wish to integrate more WMO training into their annual training plans;
  - Members are looking for easy access to the different types of training available in the WMO Global Campus Events Calendar, with registration details;
  - Members wish to have access to information regarding the planned activities early enough to incorporate them into the next year's training plan;
  - Members are looking for a database of experts who could teach different topics at a regional/global level;
  - How to secure remuneration for non-staff expert trainers;
  - Concern was expressed that focusing on the operational staff would result in neglect of the technical/IT staff.
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## **APPENDIX C. REGIONAL WORKING GROUP INPUT TO THE SYMET-14 STATEMENT**

The Regional Working Groups were as follows:

Regional Working Group RA I, English;

Regional Working Group RA I, French;

Regional Working Group RA II, English;

Regional Working Group RA III and IV, Spanish;

Regional Working Group RA IV, English;

Regional Working Group RA V, English;

Regional Working Group RA VI and II, Russian;

Regional Working Group RA VI, English.

### **Regional Working Group RA I, English**

#### ***Recommendation 1***

It is recommended that the English-speaking RA I RTCs that do have facilities partner with other RTCs to assist them in running online courses.

#### ***Recommendation 2***

It is recommended that those RTCs that are confident with online training should assist and mentor those that are not confident and do not know how to build online training material.

#### ***Recommendation 3***

It is recommended that the non-participation of learners in online training is investigated so that the true reasons are known and might be resolved.

#### ***Recommendation 4***

It is recommended that online training is recorded for those participants that cannot attend.

#### ***Recommendation 5***

It is recommended that each RTC/training institution that does not have online facilities investigate the possibilities within their country to partner with online training groups that do have the facilities.

#### ***Recommendation 6***

It is recommended that exchange of lecturers for online training be implemented, and monetary support be available for the exchange.

#### ***Recommendation 7***

It is recommended that RTCs should liaise with all governmental agencies or policymakers to help in providing the above facilities.



### **Discussion leading to recommendations**

1. Internet connections are not stable or nationwide;
2. There is a server shortage for hosting online material;
3. How can the problem of participants not attending online lessons be managed? Video on, recordings? Participant challenge – why are they not attending? If personal – can solve the issues. Cost of data can be a problem – need sponsorship. Electricity rationed. Required equipment not available. Home activities interfere with online training.

#### *Sharing*

South Africa and Egypt are willing to share online facilities by creating formal partnerships.

Practical online training – videos and so forth.

Are other countries willing to share? Or is sharing in-country with universities an option?

What are the possibilities for lecturer exchange/sharing for online training?

### **Regional Working Group RA I, French**

#### ***Recommendation 1 (to WMO)***

Regularly train teachers on the use of teaching methods and technological tools needed to teach and assess at a distance. These regular trainings could also make it possible to evaluate the methods and tools used by the participants and for them to acquire more appropriate methods and tools.

#### ***Recommendation 2 (to WMO)***

Facilitate a forum for education and training providers to share experiences and resources on pedagogical methods, technological tools and training content.

#### ***Recommendation 3 (to WMO)***

Develop a guide outlining advice and good practices for online assessment of acquired knowledge (methods and tools).

#### ***Recommendation 4 (to training organizers)***

Encourage blended training both in terms of delivery modes (distance, presence) but also in terms of types of training sessions (synchronous versus asynchronous) to meet all needs and work around technological issues.

#### ***Recommendation 5 (to training organizers)***

To minimize access issues (power cuts and Internet outage) during distance learning, allow offline access to resources and training activities, for example by making them available on SD card, CD, external hard disk.

#### ***Recommendation 6 (to training organizers)***

Broaden the scope of distance learning towards practical aspects and not only theoretical ones (for example, in forecasting, numerical weather prediction, and so forth).

***Recommendation 7 (to training organizers)***

Link acquired competencies during training to the WMO competency frameworks in order to promote the recognition of training between countries, in particular through the use of micro-credits and open badges with standardized metadata.

***Recommendation 8 (to training organizers)***

Promote and support the motivation of experts to teach, both at a distance and in person, by training them, accompanying them in designing their courses and recognizing their skills, and particularly by:

- Organizing very practical training in instructional design oriented towards multi-modal training, management and animation of a training course;
- Delivering standardized open badges to recognize their skills as trainers.

***Recommendation 9 (to WMO and all education and training providers)***

Encourage collaboration and mutual aid between training centres and universities, for example:

- Create a WMO cloud space to exchange training resources;
- Provide content reference documents to teachers to build their teaching in terms of contents;
- Organize training for teachers on new topics (such as machine learning, artificial intelligence, and so forth).

***Recommendation 10 (to WMO)***

Promote the continuous training of forecasters from countries subject to similar extreme situations (for example, medicanes) through feedback workshops on recent situations. Alternatively, rely on the existing French-speaking forum to promote sharing of experience in semi-real time, and create similar forums in other languages.

***Recommendation 11 (to WMO and education and training community)***

Announce the training courses offered, well in advance, in order to organize the work of the teams to allow participation in these courses. Currently, announcements are often too late to participate, due to the workload of teams.

Support, in material and legal terms, the creation of a training centre specific to the INM of Tunisia.

**Regional Working Group RA II, English**

***Recommendation 1***

WMO training programmes need to expand from meteorology to encompass the Earth system approach. Training in ocean, water, hydrology and cryosphere, and similar structured pedagogy education programmes which evolved in the field of meteorology, could be expanded and linkages could be made to existing training/education in other disciplines of Earth system.

***Recommendation 2***

The Training Needs aspect is important. WMO can take the lead to develop a questionnaire on Training Needs which each Member can follow to be more effective. To be effective, trainings can be more relevant to the local/regional context.

**Recommendation 3**

WMO is currently conducting a 4-year survey. In addition to evaluation and feedback from trainees, it can encompass feedback from respective Permanent Representatives (PRs) on the effectiveness of training for the relevant attendees after 3–6 months. The working group understands that WMO has been implementing such a practice, which can be followed by regional associations (RAs).

**Recommendation 4**

The language barrier is one impediment faced by attendees during regional training programmes. Here WMO could provide guidelines to assist PRs on the nomination of candidates with suitable language skills to attend training opportunities.

**Recommendation 5**

WMO has a wealth of information submitted by RTCs on their annual training programmes, including web links. It is recommended that easily accessible tools/methods with keywords be integrated in the WMO website. This will also help RTCs to develop or enhance new/existing training practices. The WMO Global Campus needs to be popularized with Members and the number of visits to the site needs to be improved.

**Recommendation 6**

It is recommended that a forum of Alumni of training attendees within RAs be created and linked, in order to globally share knowledge, experience and expertise without the hindrance of language as a barrier.

**Background to recommendations**

Capacity development is the most important way for WMO to assist bridging the gaps between observation and services, so that science can benefit society. During the discussion, the RA II working group noted that training of human resources is required, so that personnel can apply new skills and knowledge, implement new technologies and make service delivery improvements.

The working group noted that evaluating the impacts of training is critical, and that impact evaluation is described in the [Guidelines for Trainers in Meteorological, Hydrological and Climate Services](#) (WMO-No. 1114).

Discussion on SYMET-14 working group themes focused on:

- Technological barriers to online learning and using partnerships with online education providers to overcome them;
- Supporting the life cycle of professionals: From the decision to enter the discipline, to continuous learning, to maintaining job satisfaction and competency.

**Regional Working Group RA III and IV, Spanish****Recommendation 1**

Enhance institutional communication within NMHSs, RTCs and universities, encouraging active participation of education and training representatives in regional training meetings.

**Recommendation 2**

Work toward establishing a regional training network for coordinating efforts, resources and experts and identifying funding sources.

### **Recommendation 3**

Further discussion on a common credit system which might be recognized and adopted by the regional NMHS.

### **Recommendation 4**

Enhance interaction between universities and NMHSs, encouraging regular dialogue about changes in operational services and research which might require modifications to meteorology education and training programmes.

### **Recommendation 5**

Enhance collaboration between universities (regionally and globally) to work on creating or adapting existing education programmes to local needs in order to keep up with IT advances and to meet WMO standards.

### **Recommendation 6**

Support translation into different languages and adaptation to local contexts of existing shared resources, and the co-creation in native languages of new resources.

## **Background to the recommendations**

The institutional diversity in the working group provided an opportunity to discover an ample variety of needs in the region and opened the region to future collaborations.

### *Thematic areas discussed:*

The working group discussion started with *theme 9: How do we identify the critical regional needs for the professional development of operational staff? How do we ensure that appropriately qualified participants attend our training events?* This thematic area was the most oriented towards a regional discussion which could encompass any other topic of interest which might emerge from the discussion.

### *Opportunities:*

The RTC Coordination Meeting for Ibero-American and Spanish RTCs held in Lima, Perú was a key event for the region, creating the bases for a network among RTCs. The meeting resulted in adoption of the Santiago Declaration (2018). The network should now be extended to include other institutions and countries and achieve truly collaborative work.

### *Ways of identifying training needs:*

- One of the ways national and regional training needs were identified in the past was through surveys. A competency-based survey was previously completed by all the Members of the region and identified common training needs. The results were shared with the various RTCs and constitute an important source of information to orient training for different sectors within NMHSs;
- NMHSs' strategic plans for the future are another source for determining education and training needs;
- NMHSs also use international projects to identify training needs within the collaborating countries and which are common to the group. These projects are also identified as a possible funding source to develop and deliver required training for the region (examples include CLIMANDES, ENANDES, EUROclima+ and BRAVA);

- The WMO Train the Trainers Spanish course, delivered in 2021, is a third source of information where common training needs and training needs particular to a region can be identified. It also creates the opportunity to work in collaboration to create regional training on common topics;
- The WMO Marine Services Course delivered in South America was later adapted by the Marine Service in Chile and delivered to other members of staff who had not been able to participate in the first edition. It was also reorganized in order to address needs of other components of the Marine Service. The course helped the institution to identify different needs including training, which were included in future plans for the institution. The course also resulted in new regional collaboration with the Marine Service of Colombia.

### **Potential directions**

#### *Training needs identified by Members:*

The new technologies, methodologies and approaches used to deliver forecasts have created new training needs in the region. These technologies, methodologies and approaches include:

- Continuous life cycle training, which is constantly being updated to meet international standards and to keep up with IT innovations;
- Automatic weather service maintenance;
- New computational modelling techniques, data assimilation, machine learning, data mining and data science, high performance computing (HPC) cloud computing;
- New satellite products, not only focused on weather monitoring and forecasting, but also part of real-time Earth observations used in aid of an impact-based decision support system;
- Impact-based forecasting techniques. There is an increasing demand for trained personnel, particularly on account of the increase in extreme weather events and the impact they are having on society;
- Soft skills, including in communications (to interact with different users and create tailored products), project impact assessment and interdisciplinary project management;
- Disaster risk reduction, including social impact, vulnerability and exposure;
- Credit system. Some institutions use a credit system to promote staff, hence trainees would benefit more from training delivered by other institutions if courses were subject to some kind of credit system.

#### *Collaboration:*

Each of the institutions in the working group briefly commented on the various ongoing training programmes which could be made available to other institutions and countries. There are several courses available for graduate and undergraduate students offered by universities and by the Mario Gulich Institute in Argentina (which specializes in satellite training).

More feedback between universities and NMHSs is needed. Although universities deliver education to comply with WMO standards, there is not always a close link between teaching and the research being developed by professors and their groups. Moreover, there is a lack of university experts for operational areas of particular interest to NMHSs, such as marine meteorology, aeronautical meteorology or polar meteorology, which are important for our region, and there are therefore serious training difficulties in these areas. A third gap identified is that NMHSs update technical or operational techniques to follow international standards, however universities are not fully aware of these changes, and so courses delivered by the university are not updated to meet the needs of NMHSs.

On the other hand, there are university experts in the fields of water resources management, risk management and hydrological disasters, hydraulic and river engineering, hydrological simulation, hydrological forecasting and warning systems, new technologies in hydrological measurements and water security, who are eager to provide training in these fields.

*Steps that might be required:*

- Improve communication between WMO RTCs and WMO PRs within RA III and RA IV, and increase WMO communication with other education and training providers in these regions;
- Identify hydrology training needs within the various NMHSs in RA III and RA IV;
- Link experts from different institutions within thematic areas of priority interest for the region.

*Proposed future steps:*

- Compile a list of training institutes within the region;
- Hold a series of webinars where different institutions present their strengths (areas of research/training/expertise), opportunities (offered to the region) and needs (which could be addressed by other institutions in the region). Invite all institutions identified to attend these webinars;
- Promote regular meetings between NMHSs, RTCs and different training providers (universities and institutes at the local, regional and/or international levels) to enhance collaboration, keep up to date with training needs in the region, create necessary adjustments to new technologies, methodologies, and so forth. These meetings should be at least once a year;
- As part of an activity within the Leadership Course delivered by AEMET, RTC Argentina will present the outcomes of this regional training discussion group to the Latin American NMHS leaders.

*Institutions willing to take responsibility to contribute (and contributions they can offer):*

**SERVIMET, Chile** is willing to collaborate and offers IMO/WMO audit process and ISO:9001/2015 certification in maritime weather forecasting.

**Mario Gulich Institute, Argentina** is willing to collaborate and offers:

- Scholarships to complete master's or PhD degrees (geomatics and space systems) for Latin American countries covering priority topics identified by WMO or WMO RTCs;
- Funding possibilities for training development.

**SMN-RTC Argentina** is willing to collaborate and offers:

- Experts and developed courses in different areas including: radar, satellites, automatic weather stations, atmospheric observations, instrumental maintenance, data management, aeronautic meteorology and observations, climate extremes, climate services;
- Social sciences group with advanced skills in communication – Guide to Disaster Risk training.

**UBA (DCAO)-RTC Argentina** is willing to collaborate and offers experts and courses on: space weather, climate change, climate extremes, atmospheric modelling, agrometeorology, statistical and dynamical downscaling, seasonal forecasting, satellites, data assimilation and other courses within the educational atmospheric and oceanography programmes.

**FICH-RTC Argentina** is willing to collaborate and offers courses and experts on: integrated flood management, integrated water resources management and sustainable water management. Water Resources Engineering (master's degree). In the near future, Sustainable Water Management (online master's degree).

**RTC PERU** is willing to collaborate and offers funding possibilities through ongoing collaborative projects.

### **Regional Working Group RA IV, English**

#### ***Recommendation 1***

The adoption of new technologies within the workflow of NMHS personnel should be supported by dynamic training which may include the opportunity, for the trainee, to further share the acquired knowledge and developed competencies with others, as per train the trainer activities.

**Item:** Cultural or individual idiosyncrasies may limit the adoption of new practices.

*Opportunities:*

- Applying "on-the-job" practices within a regional or local focus;
- Expectations regarding active participation;
- Follow-up opportunities to share the acquired knowledge through involvement in train the trainer activities;
- Training should be interactive, short and focused;
- Availability of training in multiple languages is required.

Examples: Regional Focus Groups and virtual forums.

#### ***Recommendation 2***

Opportunities to use cloud technology for other and more diverse training should be considered and should include support in its use.

**Item:** Technology is available but not accessible or easily integrated.

*Opportunities:*

Use of cloud technology when applicable, available or required has increased as a function of the COVID-19 pandemic's impact on remote work and training practices.

#### ***Recommendation 3***

Identifying and sharing current expertise in the WMO ETR community and technical/scientific subject matters could be considered if not currently available (for example, a list of experts).

**Item:** Impact of retirements on the availability of expertise within NMHSs and the training community is of concern for some organizations in RA IV, particularly at a time of changing technologies and functions and in the context of adopting an Earth system approach.

#### ***Recommendation 4***

Increase promotion of in-house/regional activities within regional forums (for example, at regional meetings and through WMO ETR focal points and capacity development focal points) in addition to that of the WMO Global Campus.

**Item:** Knowing what resources are readily available to support training.

*Opportunities:*

The WMO Global Campus Events Calendar has proven to be an effective way to inform about training initiatives if its existence and access are known. The number of participants increase if training is relevant and accessible to a wider community.

### **Recommendation 5**

It would be beneficial if the competency frameworks include or refer to toolkits that include training and reference material (such as the [Guide to Competency](#) (WMO-No. 1205), the [Compendium of WMO Competency Frameworks](#) (WMO-No. 1209) and training available through the WMO Global Campus, RTCs or technical commissions) and ways to assess training.

**Item:** Guidance as to what training opportunities are available to support the development of competencies.

*Opportunities:*

The twinning of competency framework for aviation meteorologists with training and assessment toolkits has provided useful references for the development and delivery of training. In this situation, personnel must demonstrate that they understand and can perform functions related to the job description.

### **Recommendation 6**

Lessons learned identified through CALMet (and potentially other efforts) and innovative practices in training delivery could be increasingly shared and promoted within the education and training community at both the international and regional levels and with other stakeholders developing and delivering training.

**Item:** Online and blended learning.

*Opportunities:*

Forums such as CALMet have provided opportunities to exchange lessons learned during the last several months prior to SYMET-14. Reference material available through the WMO Learn Portal, and the [WMO Global Campus Innovations](#) publication can help support changes in training practices.

### **Recommendation 7**

As SYMET occurs every four years, and the water, weather and climate community will need to address many challenges regarding the evolution of its infrastructure, services and policies, the working group suggests that an interim update on the progress made since SYMET-14 could be considered before the next SYMET (via a document and/or short online session). This would enable the following:

- Follow-up on recommendations from SYMET-14;
- Demonstrate the high level of commitment to education and training;
- Support and foster continued collaboration within the ETR community and programmes;
- Exchange of relevant information and the promotion of WMO ETR practices and resources.



## **Regional Working Group V, English**

### ***Recommendation 1***

The wider community needs to recognize just how much education and training has shifted in the past two years. We should embrace our learnings and apply them into the future.

### ***Recommendation 2***

When delivering teaching for other countries or agencies, Members should find a mode of delivery that is accessible to all the students.

### ***Recommendation 3***

Give more emphasis to the life cycle of instructors. Consider the skill set of trainers and assessors and think about how to attract the next generation of training professionals, and how the organization will support them.

### ***Recommendation 4***

Foster greater sharing of plug-ins and tools.

### ***Recommendation 5***

Ensure support for new pedagogical approaches and the creation of assessment tools.

### ***Recommendation 6***

Disseminate more information on sharing portals, including the WMO Global Campus.

## **Background to the recommendations**

Theme 1. Securing institutional commitment to share learning resources:

- The issue is that shared resources are often not able to be integrated into the students' existing Learning Management Systems (LMSs);
- Education and training providers should use technological advances to increase sharing, such as [www.gather.town](http://www.gather.town);
- CALMet is a great forum for sharing;
- There was support within the working group for obtaining credits from other training centres, consistent with increased flexibility (this also relates to Theme 3).

Theme 4. Considering new pedagogical approaches and assessment methods, including the future uses of blended learning:

- Challenges in developing learning material within an LMS, and evaluating the effectiveness of online training, especially on technical topics;
- During lockdowns, assessment of on-the-job training was done remotely via webcam observation of the professional performing his/her duties, followed up by an oral enquiry;
- The working group noted first-hand the large amount of time needed to develop online training resources, and the advantages and disadvantages of distance learning;
- Over the past two years the COVID-19 pandemic has forced people to see the benefits of online learning. People are now expecting more flexibility in their learning activities and general work;

- During the COVID-19 pandemic, distance learning was sometimes just a version of face-to-face learning repackaged on Zoom/Teams, and so forth. There is a real need to move towards proper blended learning;
- Having been forced into some form of online learning, organizations should now reflect on what is working and what is not. They now have better plug-ins, authoring capability, portability and mobile-friendly apps;
- Flipped classes are seen by the working group as a very effective method;
- “Just-In-Time teaching” and “constructivism” were also seen by the working group as effective methods of learning;
- Instructors should give online students opportunities to converse outside of planned classes (like meeting and chatting with others in the corridor).

Theme 5. Technological barriers to online learning, and using partnerships between online education providers to overcome them:

- The working group learnt of an example of students from a small island developing State (SIDS) in the South-West Pacific region. Internet bandwidth was not good (it could be affected by heavy precipitation), meaning the students had to watch sessions twice. The students were expected to study a Basic Instruction Package for Meteorologists (BIP-M) course while working operationally;
- It was noted that good Internet connectivity can be costly;
- When taught remotely in their home country, students from SIDS often have under-powered tools to display imageries and from which to learn;
- Communications about funding of face-to-face students can be erratic, which can be exacerbated if the learners are using only mobile devices;
- Time differences between instructors and learners in other countries are another barrier.

Theme 6. Supporting the life cycle of professionals:

- During the COVID-19 pandemic it has been critical to manage student health and well-being. Students have often been isolated and vulnerable, and pastoral care is essential;
- Changes in learning in recent years have reflected the broader changes in society, with increased flexibility and more people working from home.

Theme 7. What are the content area expertise gaps within our academic teaching staff members? and Theme 9. How do we identify the critical regional needs for the professional development of operational staff? How do we ensure that appropriately qualified participants attend our training events?:

- Many NMHSs face huge operational demands. Getting instructors is difficult since they often come from technical divisions doing operational work, and need many months to familiarize themselves with the material;
- Engaging skilled competency assessors is a big issue due to the long time needed for completing full assessments;
- Meteorology is moving more towards impact-based forecasting, which requires new skills of trainers;
- Training is seen as a vehicle of change. It is all very well to update warning systems but unless NMHSs are supported and able to re-train staff, the change will not happen.

## **Regional Working Group RA VI and II, Russian**

### **Recommendation 1**

Improving meteorological and hydrological services requires developing the skills of NMHS personnel to transform meteorological and hydrological data (forecast model outputs, reanalysis data, including in situ data, remote sensing) into meteorological and hydrological products and services.

Such services require, as part of the NMHS, at least:

- Professional forecasters with their own competencies, which are well known and regulated, including in WMO documents;
- Specialists in information technologies and technologies of information transmission systems;
- Professionals who are directly involved in the provision of meteorological and hydrological services to sectors of the economy, municipalities and the population (communicators and administrators) with their specific professional and "soft" competencies.

This is practically a new multidisciplinary group of specialists in the hydrometeorological service, professionals who must have at least sufficient knowledge and skills in the fields of:

- Basic concepts of hydrology and meteorology;
- The impact of meteorological and hydrological phenomena on certain sectors of the economy and population groups, including their vulnerability associated with hazardous hydrological and meteorological phenomena;
- Management of natural risks associated with hazardous hydrological and meteorological events, including the definition and improvement of contingency plans;
- Creating specific hydrological and meteorological products that meet the needs of end users, transforming meteorological and hydrological data into meteorological and hydrological products and services, as well as mastering methodologies for determining the changing requirements of users, methods and technologies for providing services;
- Developing and delivering, in partnership with users, specific applications to facilitate the understanding and use of meteorological and hydrological products and services;
- Broad communication skills for working with end users and knowledge of social psychology.

### **Recommendation 2**

Training and advanced training of such specialists should be carried out within the framework of separate interdisciplinary educational programmes "Provision of hydrological and meteorological services", as well as through self-education in the WMO Global Campus system.

It seems that this is an important component of the response of the meteorological education system to the challenges that humanity poses in the context of rapid changes.

### **Recommendation 3**

Approve the establishment of a new WMO Board of Education and Training for the further development of the WMO Global Campus.

**Recommendation 4**

The working group supports proposals for offsetting loans received in the system of non-formal and informal education.

**Recommendation 5**

Consider/promote implementation of the work-based learning model approach for degree programmes developed jointly by NMHSs and universities.

**Recommendation 6**

The working group believes that practice-oriented teaching at universities requires a deeper immersion of teachers in the operational work of the NMHS and scientific organizations. Courses for teachers need to be organized at the NMHSs and scientific organizations, in order for teachers to participate in professional development, and for them to more effectively train students.

**Recommendation 7**

Approve capacity development strategy.

**Recommendation 8**

The working group proposes to conduct, together with the NMHSs' human resources services, a preliminary assessment of the state of the personnel potential of the NMHSs in the region. For this purpose, the working group proposes to ask NMHS employees about which topics of advanced training are most relevant to them. Furthermore, more clearly formulate the requirements for the initial qualifications of students in a particular course.

**Regional Working Group RA VI, English**

**Recommendation 1**

EUMETCAL members, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-range Weather Forecasts (ECMWF), Copernicus entities, universities, RTC's and private entities in RA VI are strongly encouraged to take tangible action to prepare resources that can be shared, and to share education and training resources between each other and globally within the WMO Global Campus framework (the WMO Global Campus resource sharing process will be really useful here). EUMETCAL is invited to take a role in promoting sharing across RA VI. When developing resources:

- Use simple language;
- Use generic diagrams that can be reused and adapted;
- Make cases easy to adapt to other parts of the work;
- Make the module/slice/lesson short (10 min);
- Do not hide your light: take the time to promote your resources, not only on WMO Global Campus but also on social media, Telegram, WhatsApp, in The Training Bulletin and professional networks.

**Recommendation 2**

Use the opportunity afforded by YouTube to enable sharing where possible.

**Recommendation 3**

Training institutions are enthusiastically encouraged to use open licenses such as creative commons, that allow for derivation (both for the material they produce and as input to the resources developed). This makes resources reusable.

**Recommendation 4**

WMO Secretariat to support the finalization of competency frameworks for agriculture and air quality.

**Recommendation 5**

Explore the Erasmus+ programme and how it might be used to enable WMO Global Campus.

**Background to the recommendations**

Sharing resources really matters and the working group believes that much more could be achieved. There is good collaboration within narrow networks but there is much scope to share more widely. Shared resources can be used in official/institutionally supported training (class/cohort-based and self-paced) as well as self-directed training.

There is quite some scope to increase the officially supported self-paced learning, however language is a big barrier here (most resources are in English).

Resources need to be developed in ways that make translation and reproduction/derivation in another language easier. The best resources are developed in the author's own language and with a local context (meteorology, warning systems, and so forth). It is necessary to be able to make derivations from good source material. This requires materials that grant permission to derive and are easy to derive (edit).

Automatic translation can help, but in some technical areas it can cause problems, particularly for materials that relate to operational warnings and decision support.

Resources created on YouTube are of particular interest. Short how-to videos can have subtitles in the original language that can then be translated. Such videos can be for technical topics as well as for public consumption. A link can be posted on the WMO website or RTC web page. Search functions should be available on these websites or web pages to facilitate finding videos of interest.

In terms of micro-credentials, at this stage, there is no framework or system to work within. One issue is how to start sharing between training organizations. Connecting resources to the competency frameworks is an important first step. Missing competency frameworks for agriculture and for air quality are a barrier here. This issue has been explored in other working groups.

The European Union Erasmus+ programme is well established and supports the development of education and training. There may be quite some scope to explore projects that help the WMO education and training community meet its needs. More limited funds for initiatives might also be available via the European Cooperation in Science and Technology (COST) association, European Geosciences Union (EGU), European Meteorological Society (EMS) or Horizon Europe?

It may assist to tag resources with the language of origin. Some people also use them to learn language.

More people are coming into the pipeline from diverse/broad backgrounds (geography, environmental science, and so forth), which is a good thing. However, operational centres have to address the variation in the people that get recruited.

Data science and machine learning is exploding in the sector now, as was seen a few years ago. It may be that the sector did not respond dynamically to the initial signals, however, that has changed now. Many of the resources prepared now are cloud-based, which both enables and limits sharing. AI translation will help in the future. Resources need to be designed for ease of translation. Hackathons on data have been interesting, and hackathons on training resources may be interesting in the future (EUMETSAT with Copernicus will try something in 2022). Very Python and Trainhub.eumetsat.int is one example of a Jupyter-based notebook library.

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## **APPENDIX D. INTERNATIONAL ADVISORY COMMITTEE FOR THE FOURTEENTH WMO SYMPOSIUM ON EDUCATION AND TRAINING (SYMET-14)**

### **Co-Chairs**

Dr Anna Timofeev  
Prof. Andrew Charlton-Perez

### **Members**

#### **Mr Omar Chafki**

Director, Directorate of National Meteorology  
Morocco

#### **Prof. Andrew Charlton-Perez**

Joint Head of Department of Meteorology,  
University of Reading  
United Kingdom

#### **Mr Christophe Cudennec**

Professor, Institut Agro, Agrocampus Ouest, France  
Secretary General, International Association Of Hydrological Sciences (IAHS)

#### **Dr Somenath Dutta**

Scientist-F and Head of Meteorological Training Institute (MTI)  
India

#### **Dr David Farrell**

Principal, Caribbean Institute for Meteorology and Hydrology (CIMH)  
British Caribbean Territories

#### **Dr Winifred Jordaan**

Head of the WMO RTC  
South Africa

#### **Jennifer Milton**

Retired Director, Canadian Meteorological Centre Operations Division,  
Meteorological Service of Canada

#### **Prof. Christoph Müller**

Director, Institute of Plant Ecology (IFZ)  
Justus Liebig University Giessen  
Germany

#### **Prof. Peter Odjugo**

Professor, Director of WMO RTC  
Nigeria

#### **Mr John Ogren**

Chief Learning Officer, National Weather Service  
USA

#### **Dr Mary Scholes**

Professor, University of the Witwatersrand, Johannesburg  
South Africa

**Mr Roger Stone**

Director, Centre for Applied Climate Sciences  
University of Southern Queensland  
Australia

**Dr Anna Timofeeva**

Executive Director of the WMO RTC in the Russian Federation  
Russian Federation

**Dr Zhiqiang Wang**

Deputy Director General  
China Meteorological Agency (CMA)

**Mr Christopher Webster**

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