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IDENTIFICATION OF MEMBERS TRAINING CAPABILITIES AND REQUIREMENTS

SUMMARY

DECISIONS/ACTIONS REQUIRED:

To review and comment upon the approach and tentative conclusions used in identifying the large scale drivers for the WMO Education and Training Programme over the next 7 years.

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IDENTIFICATION OF MEMBERS TRAINING CAPABILITIES AND REQUIREMENTS

1. INTRODUCTION

1.1 Background

This paper uses data from a variety of sources to provide an insight into WMO Members ETR capabilities' and requirements. The data sources include: an informal survey on Member staffing profiles distributed by D/ETR in the second half of 2013; responses from RA VI Members to a survey carried by the Regional Office for Europe prior to the RA VI session in September 2013; raw data from the annual surveys carried out by the Strategic Planning Office; support requests from Members to attend training events run by countries such as China, Israel and Turkey; the rate of assessed contribution for Members set by EC on an annual basis as a proxy for development status; data from WMO-No. 5 on primary language; and, data from the COMET programme on utilization of COMET modules.

The remaining part of section 1 examines some of the assumptions and limitations with the data sources. Section 2 looks at the data in more detail and Section 3 attempts to summarise the data.

In overall terms the global NMHS workforce is estimated to be between 200,000 and 220,000. Just under 25% of the global workforce is involved in the provision of weather services, with climate services and operational hydrology services around 3% each of the total workforce. In terms of mode NMHS workforces are between 500 and 1000 with extremes of 3 and more than 50,000. Generally Least Developed and Developing countries have smaller NMHS workforces than Developed countries. In terms of workforce numbers Russian and Chinese are probably used more than English with French and Spanish much less common, this is important in terms of creating resource materials in languages other than English. Whilst there is a large demand for education and training associated with weather forecasting and its specializations, in general there is more capacity to support this requirement. The areas where further capacity needs to be developed are climate services, communications and computing, environmental monitoring, equipment maintenance and installation, hydrological services and training. The ETR survey results suggest that the use of online education and training opportunities appears to be reasonably similar across each the "development" groupings, the number of staff reached is of course different.

1.2 Assumptions and limitations

Representativeness of staffing profile data: The staffing profile data comes from two sources, the main source is from responses to a questionnaire circulated by D/ETR to ETR Focal points and Directors of NMHSs in mid 2013. To date 84 responses have been received and incorporated into this data set. These returns typically have the total staff numbers as well as the breakdown against a number of common staff categories (80 responses). The total staffing data was supplemented by data from a survey conducted by the Regional Office for Europe prior to the sixteenth session of RA VI, this added another 24 responses for total staff numbers and gives a bias to RA VI countries in the data which are mainly in Development status C. See table 1.

Regional Response	Total Members in Region	Number of Responses	"Development Status" in Region (number of responses in (brackets))		
			A	B	C
RA I	53	16	46 (12)	6 (3)	1 (1)
RA II	36	15	18 (3)	8 (5)	10 (7)
RA III	12	7	4 (1)	3 (2)	5 (4)

RA IV	23	12	13 (8)	7 (3)	3 (2)
RA V	21	13	14 (7)	2 (1)	5 (5)
RA VI	46	39	9 (6)	14 (11)	23 (5)
Non Member	2	2			
Totals	193	104			

Table 1. Responses by region and "development status indicator"

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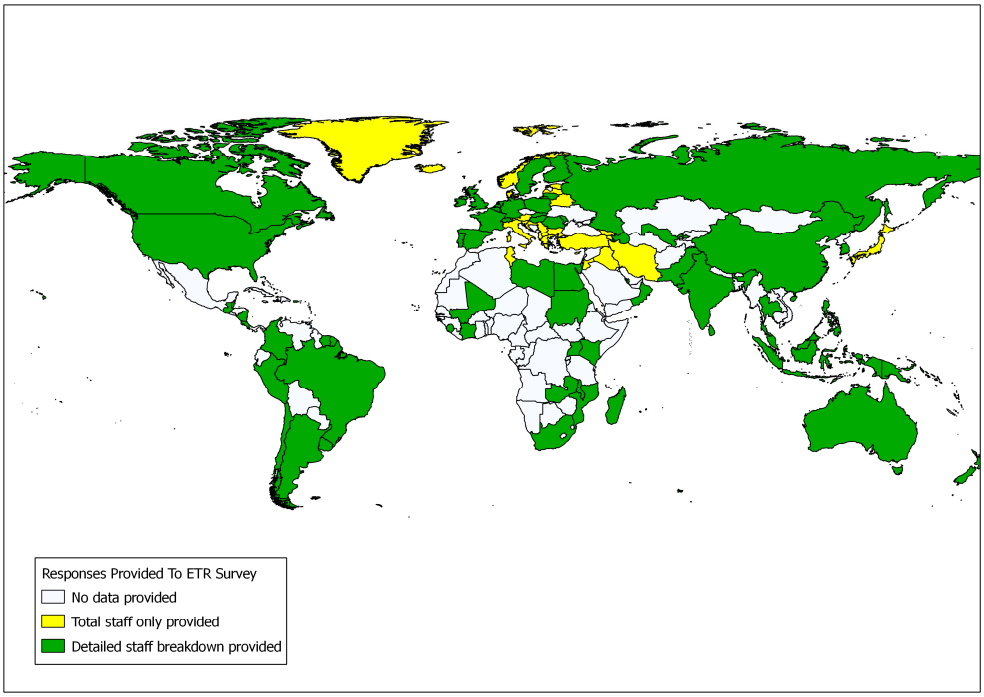

Figure 1. Responses on staffing profiles received from NMHS, colour codes show whether full responses or partial responses received.

Development status: The UN has an agreed list of countries who qualify as Least Developed Countries (LDCs) however there is not a similar description for developing or developed countries although these terms are commonly used in WMO documents. Even outside the UN there is no agreed framework for classifying countries into these latter two categories. However within WMO, the EC and Congress set and publish the annual assessed contribution for all WMO Members. The lowest level of assessed contribution is 0.02%. Using the 2013 assessed contribution data 104 WMO Members are in the lowest category, including all LDCs, thus an assessed contribution of 0.02% could be seen as a proxy for LDCs. There is no commonly agreed reference frame for who is a developing country (or a country in transition) and who is a developed country. By reference to compilations such as those from OECD and the World Bank an assessed contribution rate of 0.2 and above was selected for use as a proxy to determine developed countries. Thus assessed contributions of between 0.02 and 0.2 could be seen as a proxy for indicating countries that could be described as developing or countries in transition. This proxy schema is not perfect as there is an inexact relationship between the assessed contribution of a country (based on GDP of the country) and the development status of the NMHS in that country. See Figure 1 showing the total numbers of countries in each category and the number of responses to the ETR survey for each category. Category C is best represented.

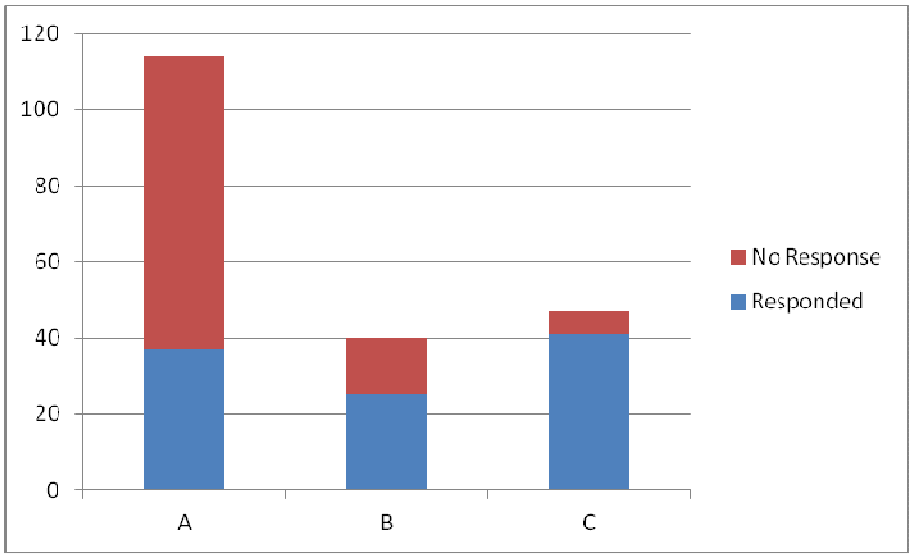

Figure 2. Number of countries in each group and number of responses responses

The use of the proxy indicator is simply to group countries with similar economic development to see if there are common capabilities and concerns for the NMHSs of those countries. In the following tables and figures A is proxy for LDCs (ie assessed contribution of 0.02%), B for developing countries / countries in transition (assessed contribution between 0.02 and 0.2) and C for developed countries (assessed contribution of 0.2% and above).

Language: WMO Publication 5 provides information regarding the preferred language of WMO Members for official communication purposes, Table 2. From an education and training perspective English is over represented in the table and languages such as Portuguese are not represented. However the table does provide an indication of the importance of languages such as French, Russian and Spanish for instruction.

Preferred Language	No. Countries specifying WMO language
Arabic	2
English	127
French	32
Russian	12
Spanish	19

Table 2. Breakdown of preferred WMO language for communication to Members

When the totals from the ETR survey are linked to the official language of communication this issue of language of instruction vs language of correspondence is much more obvious. The English language is more than 110,000 as it contains 51,000 personnel from China, plus approximately 5,000 from countries such as Japan and Indonesia. The language of instruction in these countries will not be English. For many countries where one of the major languages is not spoken widely in the country access to education and training material in the local language is a major problem.

Preferred Language	Total personnel
Arabic	
English	111632
French	4251
Russian	47389

Preferred Language	Total personnel
Spanish	4421

Table 3. Staffing numbers as a function of language of official correspondence

2. ANALYSIS AND INTERPRETATION OF THE DATA

2.1 Grouping NMHSs based on total staff numbers:

Following an examination of the total staffing numbers for the 104 countries who have provided data, it was decided to use a binomial based grouping scheme as this provided better discrimination of the data than a base 10 scheme and was easy to implement.

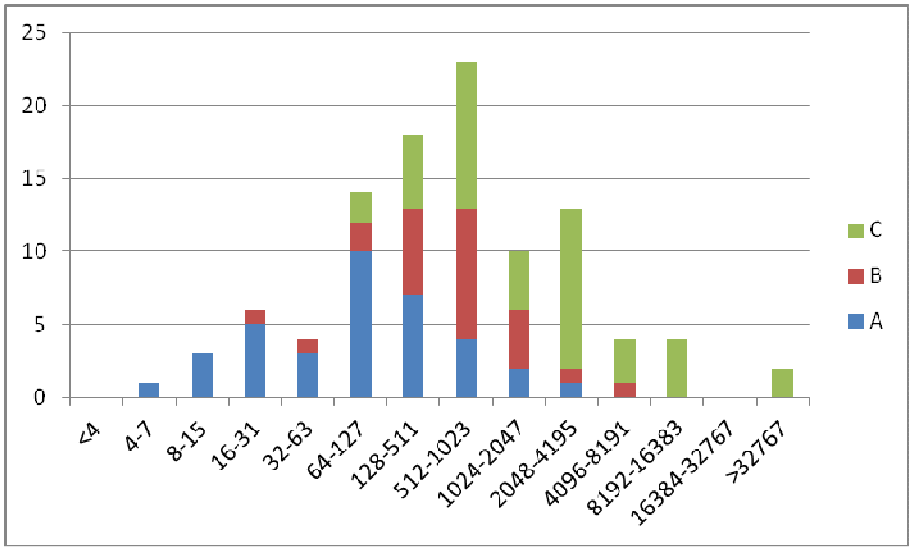

Figure 3. Size of NMHS as a function of "development status"

Thus, the NMHSs are grouped in the following categories based on advised total staff numbers: <4: 4 – 7; 8 – 15; 16 – 31; 32 – 63; 64 – 127; 128 – 255; 256 – 511; 512 – 1023; 1024 – 2047; 2048 – 4095; 8196 – 16391; 16392 – 32783; >32783. Figure 3 and Table 4 show the staffing profiles based upon the ETR and Regional Office for Europe data.

Noting that RA VI members are over represented in the numbers and that many of the RA VI members are in development category C, it suggests (reasonably) that the less developed Members generally have smaller NMHSs with the more developed NMHSs generally being larger. The distribution suggests that the majority of the NMHSs represented in this data have less than 1000 staff members in total.

Numbers of Members with staffing of	Number		A	B	C
Less than 4	1		1		
Between 4 and 7	1		1		
Between 8 and 15	3		3		
Between 16 and 31	7		6	1	
Between 32 and 63	4		3	1	
Between 64 and 127	14		10	2	2
Between 128 and 255	18		7	6	5
Between 256 and 511	23		4	9	10

Between 512 and 1023	10		2	4	4
Between 1024 and 2047	13		1	1	11
Between 2048 and 4195	4			1	3
Between 4196 and 8391	4				4
More than 8392	2				2
Total number of Responses	104		38	25	41

Table 4. Breakdown of responses by staff number and "development status"

2.2 Estimate of total NMHS workforce

Using the combined data of the RA VI survey and the ETR survey the total staffing numbers for the 104 NMHSs is 167,692. If you only consider the eighty (80) countries that supplied their staffing profiles the total is 147,349, ie the additional 24 countries (primarily RA VI) for which there are only total numbers account for around 20,000 staff. One country (RA II category A) alone counts for just under 5,000 staff. The number of hydrological staff and potentially aeronautical meteorological forecasters and observers are most likely under represented as these functions are carried out by other government departments or entities in some countries and thus may not have been correctly reported. In round terms it could be safely estimated that the global workforce for NMHSs is of the order of 200,000 to 220,000 personnel. This assumption is essentially an extrapolation of the numbers in the survey but can be tested by assuming an average staffing number of 500 people for around 90 missing countries, ie an additional 45,000 personnel. It is worth noting that two Members alone (People's Republic of China and the Russian Federation) make up more than forty (40%) of the global workforce. Fortunately from an ETR perspective they both have strong and active training institutes, not only providing education and training opportunities for their workforce but for many other countries as well.

2.3 Staffing Profiles

Table 5 details the staffing profiles reported through the ETR questionnaire. Due to an oversight in the initial formulation of the different categories the following categories were not included in the first questionnaires that were distributed, Research, Oceanography and Agro-meteorology. It is not known whether the respondents included these numbers in the other categories or did not report them, thus it is expected that they are under-reported. This data is also represented in Figure 4. The largest group of staff are involved in the provision of weather services with the majority of the staff in the professional category. The next major grouping is administrative and management also with a considerable number of professional staff. Unsurprisingly the next highest staff category is in observations.

	Reported staff numbers			
Organisation entity	Professional	Technical	Other	Total
Weather Services	27574	9072	8645	45291
Climate Services	3106	1140	316	4562
Hydrological Services	1989	1351	1605	4945
Observations	17156	7684	4399	29239
Communications and Computing	6623	1880	1430	9933
Administration and Management	19025	2755	7556	29336
Oceanography (not asked)	99		110	209
Agrometeorology (not asked)	200	120	20	340
Research (not asked)	1756	89	157	2002
Training	1009	192	451	1652
Environmental monitoring	1531	871	1988	4390

Other support functions	3971	2121	5121	11213
Equipment Maintenance and Installation	2235	1336	666	4237
	86,274	28,611	32,464	147349
Total staff over all categories *	147,349			147349

Table 5. Breakdown of staff across various functions of an NMHS

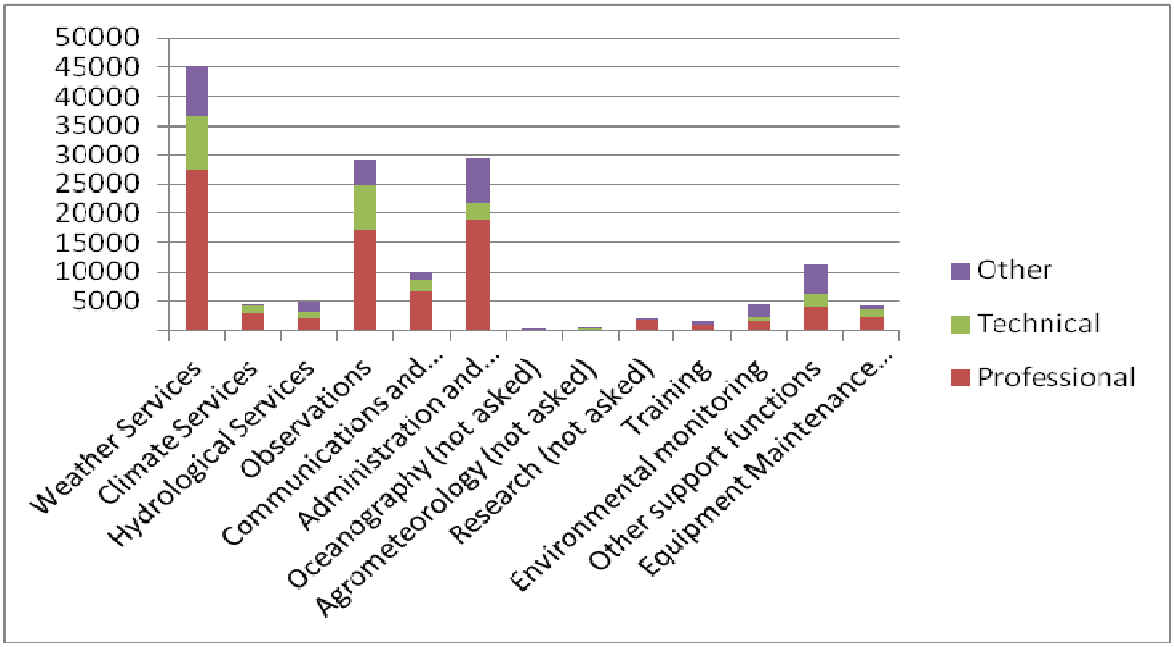

Figure 4. Breakdown of staff across function of the NMHSs

Within the weather services personnel there are over 7000 aeronautical forecasters of whom 497 will not meet the 1 December 2016 qualification requirements. Whilst this is a small number in absolute terms it will mean that 24 of the respondent countries will have 30% or more of their aeronautical meteorological forecasting staff unqualified on 1 December 2016. See table 6 The aeronautical meteorological observers are also expected to be under reported as many of these work outside the NMHS. Care needs to be taken when using the aeronautical meteorological forecasters data. The data does not discriminate between specialist aeronautical meteorological forecasters and staff who undertake some aeronautical meteorological forecasting as part of their wider weather service duties. Approximately 30% of the aeronautical meteorological forecasters are from one developed country (the United States of America) where the majority of weather forecasters have some input into aeronautical meteorological forecasts. This country also has specialist aeronautical meteorological forecasters. Figure 5 shows the number of aeronautical meteorological forecasters as a percentage of the total weather forecaster staff. It is essentially a bimodal distribution with the peak at 20% most likely corresponding to countries where only specialist AMF provide aeronautical forecasters whilst the peak at 100% most likely indicates those services where all forecasters are involved in the provision of aeronautical meteorological services.

Aeronautical Meteorology	Total AMF	Unqualified	AMO
Personnel	7037	497	8764
Members where unqualified > 30% of total AMF	24		

Table 6. Details on aeronautical meteorological staff from ETR survey

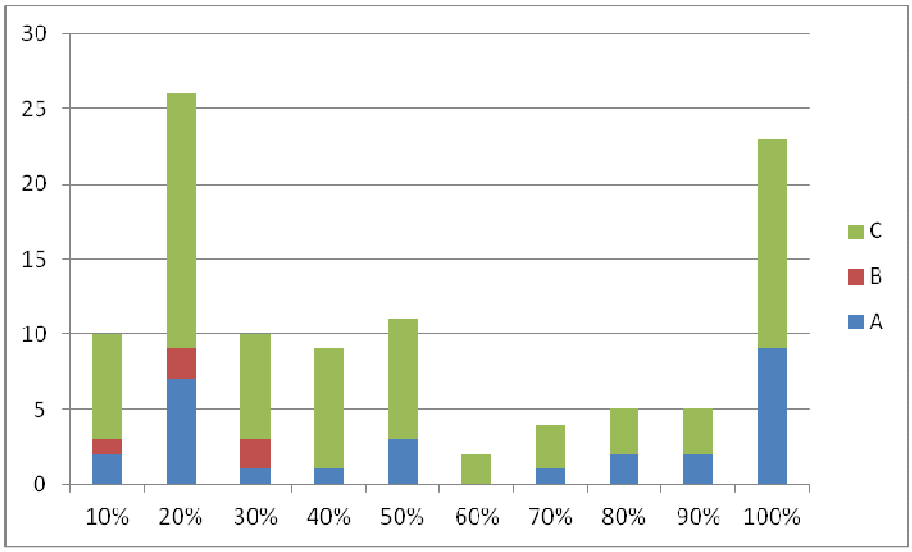

Figure 5 % of AMFin total weather forecasting. Colours indicate "development status" of countries

2.4 Member expected trends in NMHS numbers

The ETR questionnaire asked for an indication of the change in the expected workforce by 2020. Some provided numbers, other said "up", "down" or "same". All of the data has been converted to "up", "down" or "same" to allow comparison, see Table 7.

	Staff trend to increase by 2020			Staff trend to be same in 2010			Staff trend to decrease by 2020		
Organisation entity	Prof.	Tech.	Other	Prof.	Tech.	Other	Prof.	Tech.	Other
Weather Services	47	39	19	11	5	5	2	6	3
Climate Services	48	38	18	12	7	5			1
Hydrological Services	34	28	14	6	6	5			
Observations	29	37	17	9	5	2	2	7	3
Communications and Computing	39	33	18	11	9	7			1
Administration and Management	38	30	21	16	7	8		1	
Oceanography (not asked)				1					
Agrometeorology (not asked)	1	1	1						
Research (not asked)	12	6	4			2			
Training	34	25	20	12	6	6		1	
Environmental monitoring	27	26	11	9	4	6		1	
Other support functions	21	19	16	9		4		1	
Equipment Maintenance and Installation	26	27	12	7	3	2	1	2	1

Table 7. Numbers of NMHS expecting changes in staffing by 2020 in terms of "up", "down" or 'same"

Whilst this data must be viewed with some scepticism due to the external factors that will influence the outcomes, they provide a planning scenario for ETR which suggests the need to increase capacity to deal with increased demand for new staff, particularly in weather and climate services, but not restricted to these areas.

2.5 Education and Training capacity

The ETR Office survey provides some insight into the education and training capacity within Member countries, table 8. Once again care needs to be taken with the data as the quality and quantity of training offered may not be the same across the "development" categories or even within the same category. However it provides some insight. For weather forecasting, the "developed countries" have more capacity in the NMHS and within the country than the "developing" and "least developed" countries. "Least developed" and "developing" countries rely more on education and training facilities outside their own country. One positive indication is that 48 of the 80 countries who responded with this data have identified that they have at least some in-house capacity to provide training in weather forecasting.

	Initial Training in NMHS			Initial training in Country			Initial outside country		
Assessment Category	A	B	C	A	B	C	A	B	C
Administration and Management	9	5	20	18	7	18	7	5	3
Agrometeorological Services			1	17	5	16	1		
Climate Services	13	6	22	19	9	22	22	8	8
Communications and Computing	9	4	21	10	4	12	12	5	4
Environmental monitoring	4	3	11	8	6	8	11	5	3
Equipment Maintenance and Installation	4	5	13	8	5	12	14	6	4
Hydrological Services	7	5	11	15	4	14	14	7	2
Observations	16	9	25			1	10	7	4
Other support functions	4	5	13	10	5	7	5	5	2
Research		3	5	2	2	8	2	2	3
Training	6	7	14	13	4	14	11	8	5
Weather Forecasting	10	9	29	15	7	20	25	12	12

Table 8. Number of members (as a function of proxy development status) within NMHS, within country and outside of country

Using the same data, the number of NMHSs who do not have access to training within the NMHS or country is depicted in Table 9. The numbers, particularly for the "developed" countries seem a little high, particularly when the multiplying factor of NMHS size is considered. As would be expected, in most cases the "least developed" countries have the greatest needs. It appears from this data that national capacities need to be developed in the climate services, communications and computing, environmental monitoring, equipment maintenance and installation, hydrological services and training. These areas also need development within the RTC network as many RTCs do not cover these to any degree.

Assessment Category	A	B	C
Administration and Management	10	4	9
Agrometeorological Services	1		1
Climate Services	13	5	8
Communications and Computing	11	3	9
Environmental monitoring	19	8	20
Equipment Maintenance and Installation	19	5	14
Hydrological Services	22	5	19
Observations	9	3	8
Oceanography			1

Other support functions	20	7	22
Research	1	2	5
Training	17	5	14
Weather Forecasting	15	2	3

Table 9. Number of NMHSs where no initial training is available in the NMHS or country

The 2013 monitoring and reporting survey provide the following details regarding use of RTCs by Members (Table 10). The monitoring and reporting survey does not discriminate between initial and continuous professional development. The data suggests that Members primarily use RTCs in their own region but there are some anomalies. The ETR Office is not aware of any RA IV Members using RA V RTCs and the use of RA II RTCs, in particular RA II (China),by RA I Members seems very under represented in this data when the fellowship placements and the support of RA I Members to attend training events in China is considered, Table 11 shows the distribution of long term fellows and short terms training as a function of home region and host region (data from fellowships and training database). Table 11 suggests that the responses to the WMO monitoring survey may not be representative of the actual placements when all types of education and training are considered.

NMHS located in Region	No. Member Responsed	Did not use RTCs	Used Region I	Used Region II	Used Region III	Used Region IV	Used Region V	Used Region VI
1	22	0	16	4	1	2	1	4
2	16	4	1	10				4
3	6	1	1	1	4	2		
4	16	5		1	1	11	2	
5	7	1		2			4	
6	29	9		5				17

Table 10. Number of NMHSs using RTCs in their region and other regions (Data from monitoring responses)

NMHS located in Region	Used Region I	Used Region II	Used Region III	Used Region IV	Used Region V	Used Region VI
1	20	41	1			39
2		23			15	24
3		9				15
4		5		10		15
5		14			30	13
6		12				36

Table 11. Numbers of WMO fellows and very short term training participants supported by WMO Secretariat as a function of home region and host country

For continuous professional development Table 12 shows the countries that have some in country capability to provide continuous professional development opportunities. As expected the “developed” countries appear to have more capacity than the “least developed” and “developing countries” but the differences are not as marked as may have been expected.

Department	A	B	C
Administration and Management	11	4	24
Agrometeorological Services	1		1
Climate Services	12	5	24
Communications and Computing	12	6	24
Environmental monitoring	10	4	16

Department	A	B	C
Equipment Maintenance and Installation	7	2	12
Hydrological Services	5	5	15
Observations	13	7	24
Oceanography			1
Other support functions	7	5	13
Research	1	2	7
Training	8	4	20
Weather Forecasting	13	10	26

Table 12. In country capability for CPD as a function of "development status"

Table 13 shows the countries that partially or fully rely on WMO for CPD activities. Once again the least developed countries have a higher requirement for WMO support but even in the "developed" category the requirement for WMO support is quite high in areas such as weather forecasting and climate services.

Department	A	B	C
Administration and Management	7	2	2
Agrometeorological Services	1		
Climate Services	18	5	9
Communications and Computing	10	5	4
Environmental monitoring	8	3	5
Equipment Maintenance and Installation	9	3	3
Hydrological Services	13	5	4
Observations	11	6	8
Other support functions	4	4	2
Research	1		1
Training	9	2	6
Weather Forecasting	21	9	11

Table 13 Number of countries relying at least partially on WMO for CPD opportunities

2.6 Online training

The responses to the ETR survey in terms of the use of online learning to support continuous professional development opportunities in NMHSs is shown in table 14. In terms of the number of respondents it appears about 25% of the countries are using online learning as part of their CPD activities. This number is perhaps a little lower than anticipated but could just reflect the countries where use of online learning for CPD is formally encouraged. Perhaps the more surprising result is the similar use of online learning across each of the "development groups".

Department	A	B	C
Administration and Management	5	3	7
Climate Services	6	4	5
Communications and Computing	5	3	5
Environmental monitoring	3	3	1
Equipment Maintenance and Installation	3	2	
Hydrological Services	4	4	2
Observations	3	3	3

Department	A	B	C
Other support functions	2	3	2
Training	6	4	6
Weather Forecasting	6	4	10

Table 14. Number of NMHSs using online learning in each of the topic areas for CPD, as a function of "development status"

COMET Module	A	B	C
Aviation Weather	72	39	46
Climate	72	35	45
Coastal Weather	61	32	46
Convective Weather	73	38	46
Emergency Management	60	31	45
Environment and Society	73	36	46
Fire Weather	53	28	45
Fog and Low Stratus	59	38	46
Hydrology/Flooding	71	36	45
Mesoscale Meteorology	73	38	46
Mountain Meteorology	44	32	45
Numerical Modeling (NWP)	77	38	46
Oceanography/Marine Meteorology	68	35	46
Other	68	36	46
QPF/QPE (Precip)	56	34	45
Radar Meteorology	59	33	46
Satellite Meteorology	72	38	46
Space Weather	27	14	42
Tropical/Hurricanes	79	37	46
Winter Weather	47	33	46

Table 15. Number of non US NMHSs accessing COMET modules as a function of proxy development status.

The COMET Meted website requires users to login to access the COMET modules. Each user is requested to complete a profile that includes home country and affiliation. It is clear from the raw data that not all users correctly identify their home country (small islands with small or no permanent population account for a small percentage of the overall users) however the data set provides a seven year time history of what modules are of interest to COMET users. The data used in the following figures and tables selects non USA users with an affiliation to an NMHS in their user profile. In comparison with Table 14, Table 15 (based upon the COMET data) indicates that personnel for all NMHSs in the “developed” grouping are accessing COMET modules, ie taking online courses. Personnel from many of the NMHSs in the “developing” grouping are also accessing COMET modules, a lesser but still very high number of NMHSs in the “least developed” category are also using COMET modules. Table 15 supports Table 14 showing that use of online modules is widespread, Table 15 indicates that the use of online modules in the “least developed countries” may even be higher than the responses to the ETR survey indicate. Figure 6 shows the increasing use of COMET modules over time.

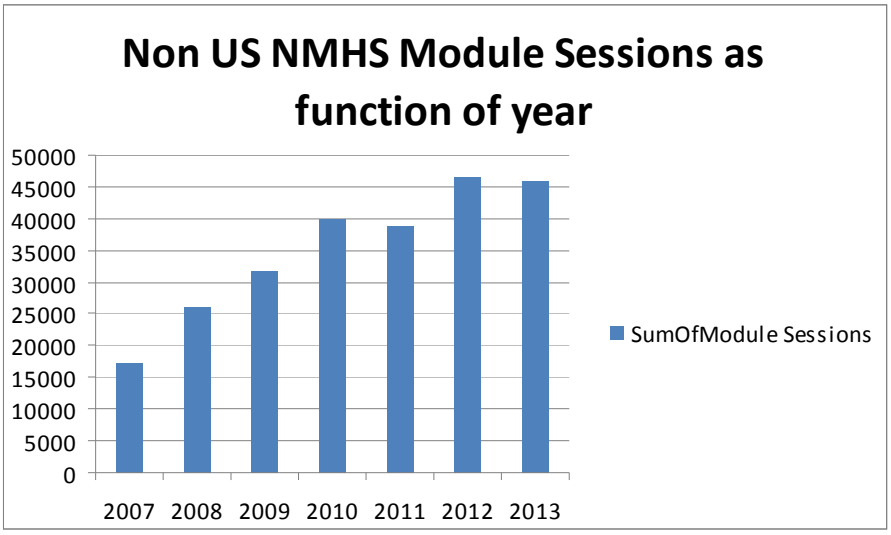

Figure 6 Non USA NMHS sessions of COMET modules as a function of year. Each session averages approximately 53 minutes

Figure 7 shows the use of COMET modules as a function of topic and by region. Region IV is consistently the highest user of COMET modules by non US NMHS personnel. Canada is a major sponsor of the COMET programme. RA VI is the next largest user (by sessions) followed by RA V, RA III, RA II and RA I. In terms of modules the most popular modules include, Numerical Modelling, Convective Weather, Mesoscale Meteorology, Aviation Weather, Satellite Meteorology, Tropical Cyclones / Hurricanes and Winter Weather. Further examination of the data shows the impact of the recent Basic Hydrology courses run by IMTR in Kenya and the National Water Academy in India (not shown) in increasing usage of these modules.

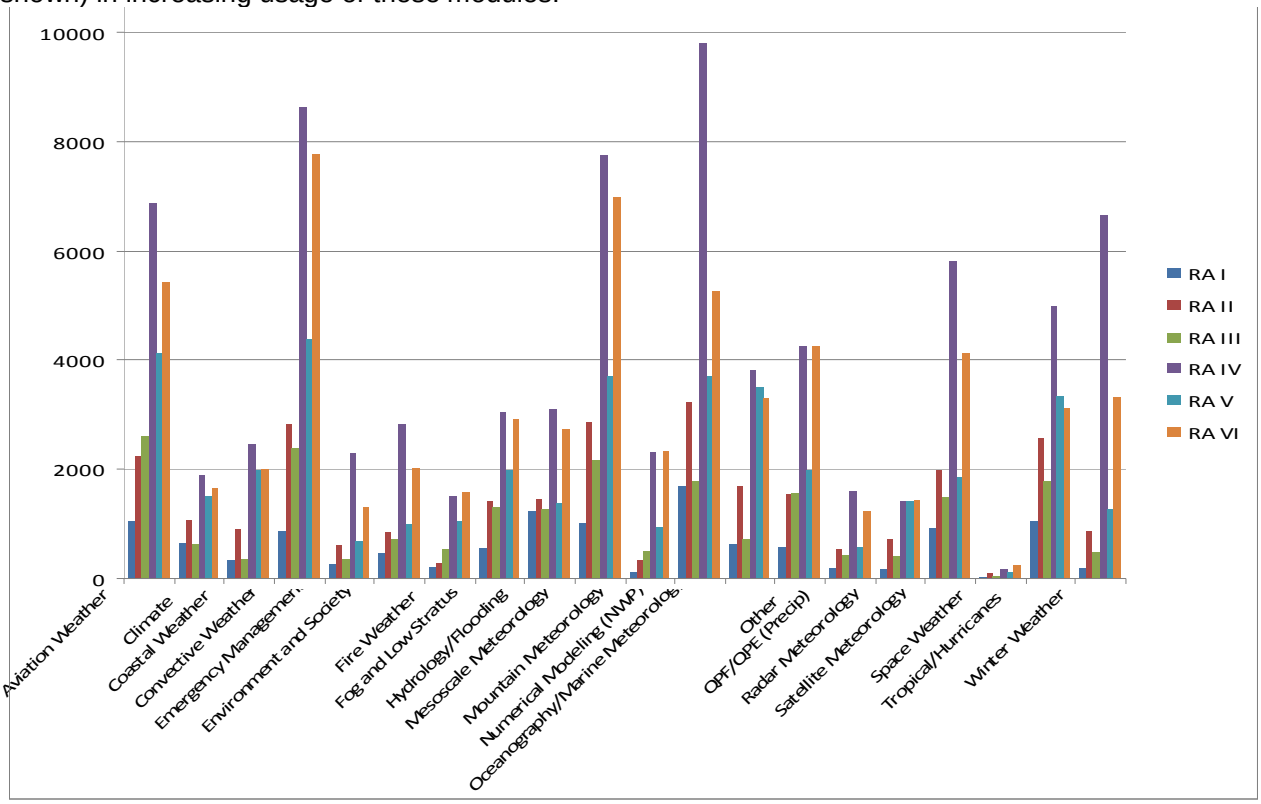

Figure 7. Non US NMHS usage of COMET modules for 2007 to 2013.

It is anticipated that the data for 2015 should show an increased use of the aviation meteorology module in Africa as a result of the Train-the Trainer activities that are currently underway in RA I and aim to equip RA I RTCs to deliver these online modules in a similar fashion to the basic hydrology modules.

3. SUMMARY

In overall terms the global NMHS workforce is estimated to be between 200,000 and 220,000. Just under 25% of the global workforce is involved in the provision of weather services and this is the category with the largest workforce in the ETR survey. The second largest workforce by category is shared between “Administration and Management” and Observations at around 20% of the reported workforce each. Climate services and operational hydrology services are around 3% each of the total workforce.

In terms of mode NMHS workforces are between 500 and 1000 with extremes of 3 and more than 50,000. Generally Least Developed and Developing countries have smaller NMHS workforces than Developed countries.

In terms of workforce numbers Russian and Chinese are probably used more NMHS staff than English with French and Spanish much less common, this could be important in terms of creating resource materials in languages other than English, however “development status” also needs to be taken into account which could favour French ahead of Chinese, Russian or Spanish.

It is expected that, on balance NMHS workforces will grow over the next 6 years although this would seem to be contrary to the trend in many parts of the “developed” world.

There is a large unmet demand for education and training associated with weather forecasting and its specializations. Whilst there is more capacity to support this requirement, it is unlikely that it will grow to a sufficient level to meet the anticipated demand unless additional sources become available. The ETR areas that show the greatest needs for further capacity development are climate services, communications and computing, environmental monitoring, equipment maintenance and installation, hydrological services and training.

The ETR survey results and COMET data suggest that the use of online education and training opportunities appears to be reasonably similar across each the “development” groupings, the number of staff reached is of course different.

This document is the first attempt at synthesising data from various sources available in and out of the WMO Secretariat. Further investigation and analysis will be undertaken over the coming months with the Panel kept informed of progress.

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