

WMO Urban Related Activities

Summary of mapping urban activities within the WMO Programmes and Departments

May 2015

A. Introduction

1. Background

Urbanization is rapidly becoming the dominant feature of population dynamics in the 21st Century exerting tremendous influence on sustainable urban development. More than half the global population now lives in cities and this percentage is expected to increase to approximately 70% by 2050. Urbanization is particularly noticeable in the developing world and in low-lying areas. The urban environment is complex and sensitive and relatively small environmental perturbations can have large impacts. Furthermore the urban environment comes in different sizes and forms, ranging from megacities with more than 10 million inhabitants to informal settlements and small villages. Many cities develop so rapidly that planning is not optimal. This often results in a habitat in which living conditions are neither safe nor healthy. Poorly planned cities result in high maintenance costs and a situation where the community is caught in an endless cycle of disaster-react-recovery which undermines sustainable development. Considering the ongoing urbanization and related expectations of more weather and climate extremes, as projected in IPCC studies, an urgent need exists to enhance the resilience of cities and their inhabitants.

The risks in the urban environment include but are not limited to: 1) flooding; 2) poor air quality ; 3) sea-level rise; 4) extreme heat and human thermal stress; 5) energy and water sustainability; and 6) public health problems caused by the previous. These urban risks are largely related to weather and climate extremes and a key question would be to better understand how these will change in a changing climate. The understanding of how and to which extent cities modify regional weather and climate, for instance through additional heat and pollution fluxes, is needed. We have to develop a common understanding on how best the weather prediction capability (or precision forecast) can be advanced on all time and spatial scales for megacities and large urban complexes. Modelling capability should be improved and integrated from regional to canopy scale to identify the urban features and illustrate urban impact processes in order to provide a core technical pillar to integrated urban service delivery on weather, climate, water, and environment related operations. Cities require the development of mitigation and adaptation strategies that balance resilience and the real-time use of weather and climate information to optimize the use of energy and other resources in the urban environment while at the same time contributing to the quality of the life of the inhabitants.

Cities also have many positive attributes. They have economies of scales that can be tapped to enhance more efficient service delivery. They provide a vibrant backdrop to innovation, cultural interaction and economic progress which exert their influence on the future mode of service delivery. They are hubs for transport, manufacturing and the latest innovation in communication and information technology. A recent study has pointed out a so-called 'superlinear scaling' observed in cities: as a city's population doubles there is on average a 15% increase in wages and patents produced per capita while at the same time requiring 15% less infrastructure per capita to provide the same services. Cities therefore inherently promote efficiencies and could, if managed well, provide part of the answer to many of the dilemmas being faced by the humankind.

2. WMO addressing urban activities

WMO and its Members can make a tangible positive impact on the urban environment by providing impact-based forecasts and integrated services that are seamless in space and time and that are targeted to the wide ranging needs of the urban population. The building blocks to do so now exist and it is an opportune time to take on the urban challenge. Long-term planning which considers weather, climate, water, and environment related risks will build more resilient and energy efficient cities. Similarly, new observations and prediction systems that will provide the different sectors and the general public specific impact based forecasts, that go beyond mere weather and climate forecasts, will have to be developed through research and its application. New service delivery models, including the role of the private sector as a partner, have to be developed to ensure that services, products and warnings do in fact have the intended impact. Guidelines and standards should be developed to assist Members, especially LCDs, to develop their capacities to address urban issues. Examples of good practices and lessons learned are to be shared between cities and NMHSs through global and regional partnerships. Clearly the contribution to sustainable cities and urban sustainable development requires cross cutting initiatives between WMO Members and between WMO departments, Programmes and activities, between research and operational applications and with other agencies and organizations involved in urban matters.

B. Summary of mapping WMO urban activities

Many WMO Members are working on urban issues but as an organization WMO has not addressed these in a consolidated manner. Therefore the Secretariat has carried out a mapping exercise of urban related activities within the Secretariat, the results are summarized below.

1. Climate related activities, including agricultural meteorology

1.1. Past activities addressing urban issues

The Thirty-Sixth Session of the Executive Council

EC-XXXVI in June 1984 considered WMO applications to urban and building-related activities and adopted in Resolution 5 the WMO Plan of Action in Urban and Building Climatology, which can be found as the Annex to the resolution. In this context, also relevant aspects of urban hydrology were included. The Plan of Action included projects, such as “Promoting co-operation with users” with the objective to promote systematic, project-oriented co-operation between NMHSs and planners, designers and decision-makers, “Effects of climate on buildings and human settlements” and “Education and training of meteorologists and users”.

CCL and CAgM

Regarding items under CCL, during the Fourteenth Intersessional period (2005-10), CCI had an Expert Team on Urban and Building Climatology, which was supported by WCAS Division in CLPA. Under the guidance of this team, topics were outlined for technical documents on Urban and Building Climatology, including a preliminary draft on Building Climatology. WMO also supported the work of IAUC in developing a bibliography on Urban

Climatology. This team also coordinated an Interregional Training Workshop on Urban Climatology, held from 6-10 September 2010 in Pune, India. Training resources have also been developed as part of this training workshop. This workshop was attended by both climate services providers and urban sector representatives. Members of this team led the expert segment session and reports on urban sector at the World Climate Conference Three (WCC-3) in 2009.

CAGM considered urban agriculture in the CAGM Report No. 90 published in May 2003, defining urban agriculture and determining the most important agrometeorological and – climatological aspects of urban agricultural production and management.

WCRP

The WCRP-sponsored Coordinated Regional Climate Downscaling Experiment (CORDEX) provides a framework for evaluating and comparing various Regional Climate Downscaling (RCD) techniques, enhancing regional capabilities for climate prediction. Recent efforts have been made for multi-disciplinary approach among physical science and risk assessment, with a view to improved use of regional climate prediction for impact and adaptation planning.

The Working Group on Regional Climate (WGRC) has been working to serve as conduit for two-way information between WCRP and the various institutions and coordinating bodies that provide climate service. With increased demand on the climate information in megacities, it is anticipated that the Group would extend its efforts to address climate information for urban community.

WCRP has worked with various partners to bring together scientists, urban planners and governments including disaster management agencies to review scientific findings and deliberate potential vulnerabilities and counter-measures. Topics of main interest are those signifying climate-related risks, included sea level rise, extreme climate events and intensification of storms and storm surges. For example, WCRP has collaborated with START, APN and other partners in conducting the “Cities and Climate Workshop” (http://www.eastwestcenter.org/fileadmin/stored/pics/Cities%20at%20Risk%20prospectus_final.pdf) held in Bangkok, Thailand in February 2009.

1.2 Current activities addressing urban needs

CCI and CAGM

The Climate Prediction and Adaptation (CLPA) Branch currently does not have an explicit urban focus. A number of on-going areas of activity relevant for urban settings include, however, such things as:

- drought risk management
- climate resilient agriculture (relevant for urban food supply, trade and agribusiness),
- heat wave health early warning systems
- climate services for renewable energy and climate-resilient energy systems
- capacity development for implementation of climate-services.
- Climate Services Information System (CSIS) including products, operational practices and toolkits that can include the needs of the urban sector
- Climate risk and sector-specific climate indices

- Guidance on climate risk management
- User interface for climate information
- Tailored climate information
- Regional and national climate outlook forums with possibility for urban sector Engagement.

The Chief of World Climate Applications and Service (C/WCAS) is the WMO Focal Point for the International Association for Urban Climate (IAUC). CLPA is coordinating the WMO co-sponsorship of the 9th International Conference on Urban Climate (ICUC9, Toulouse, 20-24 July 2015).

Biomass burning, including prescribed agricultural burning, can have strong effects on regional and urban air quality. Smoke and haze warnings are important in dealing with the impacts.

WCRP

Core projects of the WCRP (on cryosphere, water cycle, stratospheric-tropospheric process and climate-ocean variability), and now through the Grand Challenges, WCRP activities are focusing on developing reliable information regarding climate analysis and projection.

GFCS

The Second Session of the Intergovernmental Board on Climate Services IBCS (IBCS-2) that was held from 10 to 13 November 2014 in Geneva agreed that urban activities related to climate be included as a specific cross-cutting element within the priority areas of the GFCS (agriculture and food security, health, disaster risk reduction and water).

The World Health Organization (WHO) and WMO have joined forces to tackle the increasing risks to human health posed by weather and climate hazards such as extreme temperatures, floods, droughts and tropical cyclones. A WHO/WMO Climate and Health office has been established in July 2014 under the auspices of the GFCS to promote the coordinated development and use of climate services to improve public health. It will increase awareness, build capacity, and connect meteorological services with experts in the health sector in an active partnership for climate adaptation and risk management. These activities are also relevant in the urban environment.

There is an increasing demand from the health community for improved access to climate and weather products like regional climate predictions, hazard warnings and seasonal outlooks needed to understand and manage health risks related to weather and climate and to cope with a shifting burden of disease due to climate change. Millions of people each year are affected by extreme weather events such as heat and cold waves, tropical cyclones, floods, and droughts. These events also damage or destroy health facilities and water and sanitation infrastructure, and result in unnecessary deaths and illness. Yet the most significant impacts often occur indirectly and more slowly, such as under-nutrition resulting from crop failure, respiratory diseases from poor air quality, and water-borne and vector-borne diseases. Climate-informed preparedness and prevention can greatly reduce these health risks.

1.3 Future plans and requests for actions

CCL and CAgM

Regarding CCL the following activities are identified: heat-health warning systems, climate information for urban planning and operations such as water management and drainage systems, climate early warning for disaster risk reduction, climate-smart urban infrastructure (including buildings and urban spaces), etc.

It is necessary to consider climate characteristics of urban conglomerations for climate service provision. Climate services for renewable energy and urban planning (hazard data for risk assessments) and heat wave health early warning systems are likely to be areas of increasing demand.

Integrated drought and water management are important application areas within agricultural meteorology, megacity needs would need to be represented in these plans. Climate change mitigation with green space is an area to be considered. The air pollution produced in urban areas has effects on surrounding areas, especially ozone on the crop production.

WCRP

There's an emerging voice for the need for WCRP and WWRP to together address urban populations and environments – where hourly-to-decadal time scales, regional geographic scales and seamless coupled weather-climate modelling capabilities become more urgent and more challenging - in a prompt, effective and coordinated manner.

In particular for those major cities in coastal zones, more reliable information should be provided for water resourcing, extreme storm events and climate trend predictions, to support sound local decisions about investments and town planning.

Together the relevant components of WWRP, CORDEX and other WCRP components provide a solid basis to address the issue of climate information for cities. Aiming to improved climate services for urban communities, the core contribution of research programmes should include the continuous review of technologies / prediction skills that respond to the user requirements, identifying and answering to the science gaps, and ensure usability of available climate information/knowledge – to be carried out in parallel with user interaction.

There are significant demands on improved prediction for weather and climate extremes, particularly the sea-level related extremes in coastal cities.

GFCS

An interesting example is provided by China who has made a lot of progress not only in developing its national framework for climate services but also in developing and using climate services at the municipality level to support local decisions. There are very specific climate products and services being provided to different users by integrating climate information into decision support tools at the municipality level. Products are being provided for urban planning and disaster risk reduction applications, for example. China's experience will be documented through a 5 min video.

The WMO/WHO Office will work together with the Climate and Clean Air Coalition (CCAC) Partners on the Urban Health Initiative (UHI) which is planned to start in 2016. The overall goal of this project is to realize reductions of Short-Lived Climate Pollutants (SLCPs) in cities through joint, complementary action by urban health and development sectors, and by reinforcing the important linkage between SLCP and air pollutant mitigation, and health benefits. Meteorology and climate, including climate change, play important roles in this activity as they are key to the observed concentrations of pollutants in the atmosphere once the pollutants are emitted into the atmosphere.

2. Observations, including WIS and WIGOS

Traditionally meteorological measurements in urban areas have been made predominantly at airports by NMHSs, and variably at other locations. Measurements may be made in urban areas by other authorities, such as municipal ones. Air quality measurements may be made by several types of authorities, such as the local branch of the NMHS, environmental agencies, municipal authorities and research institutes.

When and where urban activities will be taken on board, it needs to be emphasised that it is important to look at standards and practices very early in the process as adding these later adds significantly to the cost of such changes to Members who actually operate WIS, GDPFS and observing systems.

2.1 Past activities addressing urban issues

WIS and WIGOS

CBS has worked to establish the required international metadata standards to ensure that data and products are properly described so specialist users, especially those supporting decision making systems and processes, can more readily find and access relevant data. Particularly important to urban applications has been the adoption of spatial data standards and practices that will align with the types of systems and standards used by town planners and infrastructure suppliers and maintenance.

Another major element has been the framework developed under WIGOS for the bringing together of data from various stakeholders. In the urban sense, this would include the various infrastructure suppliers as well as emergency services and other crucial urban components that traditionally tend to work in silos, sharing information was often a very tedious and expensive component. With the infrastructure of WIS and the collaboration framework of WIGOS, NMHSs once appropriately trained should be able to implement these frameworks and practices required to make often independent partners work as if an integrated unit.

CIMO

In the CIMO Guide a section on Urban Observations has been included. The outcomes of CIMO instruments intercomparisons are indirectly relevant to urban needs: the outcomes of the Intercomparison on Rainfall Intensities have relevance to urban sewage systems. Idem for the currently on-going Solid Precipitation Intercomparison Experiment.

2.2 Current activities addressing urban needs

WIS and WIGOS

WMO regional associations (RAs) are leading Members through the RAs implementing and benefiting from WIS. Monitored Regional WIS Implementation Plans are being put in place to ensure Members are able to have access to the new functionality of WIS. The 15 Members operating Global Information System Centres (GISCs) are taking a leading role in training NMHSs that they are associated with to help them develop the appropriate competencies to be able to use the WIS infrastructure and services. Once enabled and properly trained, NMHSs will be able to register and train those decision makers involved in urban issues to be able to use WIS. Decision makers involved with urban issues will also be able to identify what products the NMHS and other WMO contributors produce that will be of special use to them.

Regarding the designation of centennial observing stations, identification of criteria to capture the influence of urban growth on observing stations is needed.

CIMO

The only explicit activity is the maintenance of the CIMO Guide Chapter on Urban Observations, which provides Members with guidance on the siting, exposure and metadata requirements for instrumentation for urban meteorology.

The focus of Instruments and Methods of Observations (IMO) is WIGOS: observing infrastructure and programmes for multiple purposes. The driver for IMO activities comes from the Rolling Review of Requirements (RRR). If additional guidance is required from the Instruments and Methods of Observations Programme (IMOP) for Urban Services, the requirements should be elicited through the RRR, or through specific request for guidance/support to the CIMO Management Group.

GEO

The GEO Task SB-04 on Global Urban Observation and Information has defined several targets (and related activities and outputs) for the GEO Work Plan period 2012-2015.

The targets include, amongst others, the integration of global urban observations with

- (i) data characterizing urban ecosystems, built environment, air quality, and carbon emissions;
- (ii) indicators of population density, environmental quality, and quality of life;
- (iii) patterns of human, environmental and infectious diseases.

The following are the key activities:

- (1) Conduct global urban analyses, including time-series for assessing mega-cities development (e.g., urban sprawl) and a world-wide inventory of human settlements based on satellite data;
- (2) Create a global urban morphological database for urban monitoring / assessment and climate modelling to better understand the impacts of global climate change on urban areas, and
- (3) Define requirements for global urban monitoring and assessment in terms of data products and expectations for data validation, archiving, update and sharing.

This includes the Global Urban Supersites Initiative with eight large to megacity size cities participating.

2.3 Future plans and requests for actions

WIS and WIGOS

A major issue will be that the spacial scale of traditional WMO activity is significantly broader (lower resolution) than urban developers and managers work with. Once more is known about what products and services are needed, CBS will need to review its standards and practices to ensure that the appropriate scales can be supported. This affects GDPFS as well, which will ideally be able to downscale its products that are based on dynamic meteorological and hydrological processes to better support the statistical type of models used for urban planning and development as well as emergency response.

In short, CBS will need to fully understand users' needs to make sure our standards can meet these needs and integrate, or at least be interoperable with, the tools and needs of urban stakeholders.

In general, WMO technical activities are cross cutting and are enabling Members to make much better use of WMO systems and increasing their value by being interoperable with partners and key stakeholders. Urban activities are typical of the types of activities Members can start to improve their services to and involvement in as a result of activities such as WIS and WIGOS. GDPFS is also starting to take on such an approach and will bring the World Weather Watch expertise, practices and infrastructure to new areas such as urban development and activities.

In particular, the information management and involvement with other international standards organizations such as ISO and OGC can be beneficial to WMO Members developing along these lines. By understanding urban needs, WIS service providers will be better able to fine tune their systems to be able to meet the needs of specialist users such as those involved in urban activities.

There needs to be much research done through the services and research arms of WMO, and the WIGOS, WIS and GDPFS need to ensure that those undertaking this research are fully aware of what WIGOS, WIS and GDPFS are really offering and enabling. In short, which ever arm of WMO takes the lead, it needs to involve the technical infrastructure experts at all stages. This was demonstrated with Disaster Risk Reduction and the UN Humanitarian activities.

Identification of observational data sets from urban conglomerations for urban climatology studies and services as well as model evaluation would be needed. Another application area would be the consideration of specific impacts of climate anomalies on urban conglomerations when issuing climate watch advisories (cf. http://www.wmo.int/pages/prog/wcp/wcdmp/index_en.php)

CIMO

The activities mentioned under current ones are relevant also in the future. Radar Quality Control and Quantitative Precipitation Intercomparison may have some relevance for urban meteorology.

There is growing interest and activity in using mobile phone signals (wet delay) for rainfall estimation. This may have particular relevance for urban meteorology, where network usage is so high.

Satellite observations

Mapping of urban areas (land cover, land use, terrain elevation, air quality, land surface temperature) is important for: pre-disaster exposure assessment, and post-disaster recovery; for assessing climate change adaptation measures; for monitoring health hazards; for tracking emission sources

GCOS

The Sixteenth Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-XVI), held in 2011, touched upon the issue of urban observations. Recognizing the human element with respect to climate change and climate change impacts, and acknowledging linkages between climate change and air quality and among research, observations, and services, the Panel recommended development of a scoping study to evaluate and prioritize observation-related needs for understanding and predicting urban climate. Undertaking this study has not yet taken place and will be considered further.

Regarding Essential Climate Variables (ECVs), the one closely related to urban issues is Land Cover.

Global Atmosphere Watch (GAW)

The Global Atmosphere Watch (GAW) Programme that deals with atmospheric chemical composition (such as greenhouse and reactive gases, ozone and precipitation chemistry) and related physical parameters (such as solar ultraviolet radiation and aerosols) has been observing and assessing these components on the global and regional scales. CAS-16 (held in 2013) recommended to expand the GAW observation stations to include also the local scale, which would include urban environments. These stations would provide important locally representative information to be used for many purposes, e.g., air quality studies and forecasting, health studies, and urban climate services. It is not the intention to capture existing urban network observations within GAW under this new "local" site designation, but rather to be able to include sites influenced by urban or industrial complexes.

GEO

Please see above "Current" section.

3. Flood management

3.1 Past activities addressing urban issues

Training course on Integrated Urban Flood Management, Kuala Lumpur, Malaysia

Following a request for assistance from the Department of Irrigation and Drainage (DID), Malaysia in 2009, the Associated Programme on Flood Management (APFM) helped develop a capacity building programme on Integrated Flood Management for DID. It included

a training workshop in August 2009 with the objective to introduce the concept of Integrated Flood Management (IFM) into existing flood management and mitigation plans, while an integrated water cycle management program was being implemented by the Ministry of Natural Resources and Environment. As an outcome, key guidance documents such as the “Urban Stormwater Management Manual for Malaysia” have been locally developed, applying the main components of an integrated flood management approach. Following the previous workshop in 2009, in 2013 DID requested APFM to support another training course with the particular focus on “Integrated Urban Flood Management for Malaysia“ towards sustainable flood management for cities, which was held on 19- 22 November 2013, in Ampang, Malaysia. The course was jointly organized by APFM, SKM PMB (Sinclair Knight Merz – Perunding Mahir Bersatu), DID and the Malaysian Water Partnership / Malaysia Capacity Building Network (MyWP / MyCBNet). As part of a collaborative programme between Cap-Net/UNDP and APFM, the training course sought to build capacity of water professionals, trainers and capacity builders, local authorities and other stakeholders managing urban floods in the context of integrated water resources management.

The workshop was particularly based on the “Integrated Urban Flood Management” Training Manual, jointly developed by CapNet and APFM. The main objectives of the training course included the following:

- 1) to improve capacity builders’ knowledge of urban waters/floods and their management within an IWRM approach;
- 2) to stimulate capacity development actions and training activities on Integrated Urban Flood Management in Malaysia by MyCBNet / Aguajaring & network partners;
- 3) to exchange knowledge and good practices in urban flood management approaches at the Malaysian level, and how best to transfer such knowledge to urban water managers; and
- 4) to promote networking for capacity building in urban flood management approaches in water management.

The training course was complemented with a field visit to the Stormwater Management And Road Tunnel (SMART) Project, as well as a site visit to DID’s operational integrated Flood Forecasting and River Monitoring system for the Klang River valley (iFFRM).

Contribution to the World Bank publication “Cities and Flooding : A Guide to Integrated Urban Flood Risk Management for the 21st Century”

The Guide serves as a primer for decision and policy makers, technical specialists, central, regional and local government officials, and concerned stakeholders in the community sector, civil society and non-governmental organizations, and the private sector. The Guide embodies the state-of-the art on integrated urban flood risk management. The Guide starts with a summary for policy makers which outlines and describes the key areas which policy makers need to be knowledgeable about to create policy directions and an integrated strategic approach for urban flood risk management. The core of the Guide consists of seven chapters, organized as:

Understanding flood hazard; understanding flood impacts; integrated flood risk management (structural measures and non-structural measures); evaluating alternative flood risk management options: tools for decision makers; implementing integrated flood risk management; and conclusion.

Each chapter starts with a full contents list and a summary of the chapter for quick reference.

3.2 Current activities addressing urban needs

Some publications developed by APFM and its partners are available on the APFM website (Ad-hoc trainings on this topic are available through the HelpDesk on IFM):

a) Training Manual on Urban Flood Management

The document was prepared as a basis for a course of the same title aimed at decision-makers, professionals of various fields of knowledge, working in the field of the urban environment as administrators, legislators, engineers, architects, geologists, biologists and others. The course aims to present a comprehensive view of the management of urban rainwater, which will also include urban drainage and river flooding in cities. The course does not address project-specific aspects, but attempts to tackle the strategic aspects of management and the interfaces with the various aspects of urban water and other elements of city planning and management.

b) Integrated urban flood management

This training manual addresses a broad spectrum of relevant issues in this emerging field of integrated urban flood management. It is expected to provide course participants and practitioners with best practice concepts and application with the intention to further inform and engage stakeholders in promoting integrated and cooperative approaches in water management in general. The manual integrates expertise from disciplines such as hydrology, sociology, economics, architecture, urban design, construction and water resources engineering and management. The subject is approached from an international perspective and case studies, exercises, expert advice and literature recommendations are included to support the theory and illustrations.

c) IFM Tool on Urban Flood Management

The tool aims to bring the different aspects of urban flood risks together under the umbrella of a risk management approach that aims to explain urban flood risks as well as to show possibilities of how they can be managed successfully. This tool argues that only the combination of spatial, technical and organizational measures will lead to a more sustainable and effective management of urban flood risks.

d) IFM Tool on Urban Flood Management in a changing climate

The main thrust of this tool is to examine major aspects of urban flood management through in the context of climate change. This document deals with the “management” process and less about the technical, structural, and capital-intensive strategies usually pursued in coping with urban floods. It also explores the vital interaction and necessary overlap of urban flood management with land use management, urban planning, socio-economic development, and public awareness and participation. All of these issues lie at the core of planning for and carrying out strategies for climate change adaptation. The tool includes the concepts from both tools “Flood management in a changing climate” and “Urban flood risk management,” while at the same time describing specific issues and practices related to climate change in an urban environment and to increasing resilience of the population.

APFM is also participating in the FP7 EU-funded project on Preparing to Extreme And Rare events in coastal areas (PEARL). Rapid urbanisation in coastal areas combined with climate change and poor governance can lead to a significant increase in the risk of local pluvial flooding coinciding with high water levels in rivers and high tide or storm surges from the sea,

posing a greater risk of devastation in coastal communities. Based on the belief that problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious symptoms, the PEARL project aims at developing adaptive risk management strategies for coastal communities focusing on extreme hydro-meteorological events, with a multidisciplinary approach integrating social, environmental and technical research and innovation.

Additionally, the Flash Flood Guidance System (FFGS) currently implemented in selected regions of the world jointly with USAID, provides a forecasting and early warning system for flash floods, usually affecting mountain areas or highly urbanised (and therefore with an increased runoff) areas.

3.3 Future plans and requests for action

In the framework of the IFM Tool series, a number of other publications are covering topics related to floods in the urban environment: flood proofing, flood mapping, management of flash floods, flood emergency planning, flood loss assessment, etc. All these Tools focus on specific technical aspects, which need to be organized and presented through a Primer that will be developed during 2015. The topic of urban flooding will remain of utmost importance in the APFM agenda, because of the higher impact that flood events have on the urban environment and because of the need for more detailed information regarding modelling and assessment of flood impacts in human settlements.

A particular mention should be given to the topic of informal settlements, which represent an already vulnerable reality which can only be exacerbated by flood events: increasing the resilience of people living in these areas would also be crucial to minimize loss of life and maximize net benefits from the use of floodplains

4. Public Weather Services

4.1 Past activities addressing urban issues

The services outlined under current activities have been supplied by many NMHSs through their PWS work. These services are gradually improving due to better science and understanding of the impact of urban areas on natural phenomena and vice versa. A particular area of past emphasis for the PWS Programme has been the development of nowcasting capabilities of NMHSs to allow better prediction and warnings of convective precipitation leading to flooding. The international nowcasting project organized in Shanghai during the EXPO 2010 was such an example which brought together a number of countries to use various nowcasting systems to provide services to the organizers and the visiting public during the 6 months of the Expo.

4.2 Current activities addressing urban needs

Every aspect of public weather services provided by NMHSs in the total framework of service delivery impacts the daily routine operations of any urban environment including those of megacities. The most important aspect of this is the provision of warnings of severe weather which could as is very well known, bring an entire city to a halt due to excessive precipitation (rain, hail and snow). Location specific information (when available and

provided) could help the city authorities to manage the movement of people and vehicles relatively smoothly by planning ahead and taking contingency measures. Similarly, the public warnings and information about the air quality (pollution as well as pollen) can help urban dwellers adjust their level of exposure to elements that are harmful to them. All such information is currently available and included in the routine daily forecasts or warnings of a number of NMHSs for many cities as part of their public weather services. The current emphasis on moving towards impact-based forecast and warning services spearheaded by the PWS Programme will put the emphasis in responding to the exact requirements of users for more useful, user friendly and easy to understand information relating to the impact of the hazards and not just the hazards alone. PWS Programme works closely with NMHSs in improving their service delivery capabilities.

4.3 Future plans and requests for actions

Impact-based forecasting will gradually become particularly important in the urban areas and megacities due to the need to manage the flow of traffic, movement of people and the routine activity of the city in a safe and efficient environment. In addition to the public safety, two special areas that will require these kind of services will be the transport and public health sector.

The work of the newly established CBS/PWS Task Team on Impact Based Forecasting based on the CBS- approved WMO Guidelines on Impact Based Forecast and Warning Services will contribute to this issue. In addition the implementation of the Congress-approved WMO Strategy for Service Delivery will provide a tool to be applied especially to the provision of improved services in urban areas.

Understanding the exact user (very many sectors that co-exist in the cities) requires special attention of NMHSs.

It is important to make sure that research is properly translated and applied to service delivery taking into consideration the growing need of users and the increasing levels of demand and sophistication of users. The information needs to be supplied where, when and in the format that could be helpful for decision making by users.

5. GAW Urban Research Meteorology and Environment (GURME)

5.1 Past activities addressing urban issues

The WMO GAW Urban Research Meteorology and Environment (GURME) has been established in 1998 to enhance the capabilities of Members to address meteorological and air quality (AQ) aspects of urban pollution, and related weather-sensitive public health threats. GURME provides an international platform for cross-cutting urban air pollution activities, with involvement of NMHSs, environmental agencies, municipal authorities, academia and other international initiatives.

GURME's activities include setting up pilot projects in megacities addressing observational and modelling needs with clear links to users, working from research through operations to services and products, and capacity development. The Shanghai Multi-Hazard Early Warning System (MHEWS) project that was successfully demonstrated at the 2010 EXPO is

a very good example of cross-cutting collaboration between WMO Programmes. The Shanghai GURME project provided the seed for this undertaking.

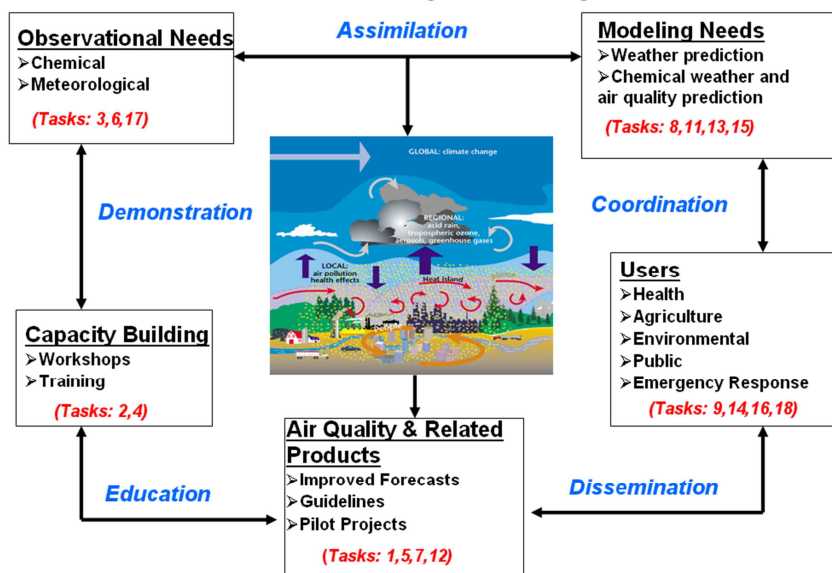
Within GURME pilot projects, the System for Air quality Forecasting And Research (SAFAR) (<http://safar.tropmet.res.in/>) in India has been established in Pune as a follow-up to the New Delhi one, and the system will be further implemented in four other Indian cities. Pilot projects have continued in Shanghai and for all of China, the latter a CMA/GURME project on near-real-time data delivery for air quality forecasting (AQF). Forecasting for the Youth Olympic Games, held in August 2014, in Nanjing, China, benefited from the expert advice given through GURME. Training was given on AQF for South-East Asia in Malaysia in the spring of 2015. Activities in Latin America include: AQF training held for Central America in Costa Rica, October 2011, and a Workshop towards an Integrated Observation System for South America: AQ and AQF in Megacities, held in Santiago, Chile, January 2012.

Several relevant reports can be found in the GAW report list (<https://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html>) such as those published with COST action 728, for instance “Review of the Capabilities of Meteorological and Chemistry-Transport Models for Describing and Predicting Air Pollution Episodes” (GAW Rep No 187). The joint WMO/IGAC report on Impacts of Megacities on Air Pollution and Climate was published in 2012 and received broad media coverage. This was a first ever assessment of this issue globally. It is available as GAW Report No. 205, see below list of publications.

5.2 Current activities addressing urban needs

Please see GURME website for activities (<http://mce2.org/wmogurme/>), the below figure summarizes these. The tasks in the figure refer to those in the GAW Strategic Plan, GAW Rep. No 172.

GURME Tasks For The Strategic Planning Period 2008-2015



5.3 Future plans and requests for action

Closer collaboration with WWRP and WCRP is planned. It is to be expected that further GURME pilot projects will be established and current ones will continue as planned. The collaboration with the World Health Organization (WHO) will continue to be important recognizing that it is estimated that globally seven million people are dying prematurely annually due to poor air quality. Specifically GURME will partner with the CCAC Urban Health Initiative, which is being established in collaboration with several CCAC Partner organizations and countries. Capacity development will continue to play an important role, as will collaboration with relevant scientific institutes and projects.

6. Coastal Inundation Forecasting Demonstration Project (CIFDP)

The Coastal Inundation Forecasting Demonstration Project (CIFDP) was established in 2009 to facilitate the development of efficient warning systems to protect communities from coastal inundation in disaster-prone countries. It is a joint activity of JCOMM and CHy. This undertaking is important for coastal cities. More information can be found at <http://www.jcomm.info/CIFDP> with the related brochure at http://www.jcomm.info/images/stories/2013/cifdp_march2013.pdf and project description at: http://www.jcomm.info/index.php?option=com_content&view=article&id=168

7. Current or possible collaborative partners in urban activities

The below are some of the organizations, institutes and other bodies relevant in addressing urban questions in weather, climate, water and related environmental fields, and which are current or would be possible collaborative partners.

UNHABITAT <http://unhabitat.org/>

ICLEI - Local Governments for Sustainability <http://www.iclei.org/>

UNISDR (especially in relation to the "Making Cities Resilient" campaign
<http://www.unisdr.org/campaign/resilientcities/>)

UNDP ART Programme

(http://www.undp.org/content/undp/en/home/ourwork/partners/regions_and_localauthorities/)

WB's CAPRA initiative <http://www.ecapra.org/>

EU's Congress of local and regional authorities

(http://www.coe.int/t/congress/presentation/default_en.asp?mytabsmenu=1)

World Health Organization (WHO)

Climate and Clean Air Coalition (CCAC), especially upcoming Urban Health Initiative (UHI)
(<http://www.ccacoalition.org/>)

IAUC

World Federation of Engineering Organizations

UN mechanisms addressing the use of satellite data for mapping applications:

UN SPIDER

UNITAR/UNOSAT

UNOOSA

International Charter Space and Major Disasters

ISO

Open Geospatial Consortium (OGC)

National and Regional Meteorological Societies

Many Universities/Academic Institutions

Environmental agencies monitoring air and water quality in cities

Some relevant publications and websites

1. Establishing integrated weather, climate, water and related environmental services for megacities and large urban complexes – initial guidance (http://www.gfcs-climate.org/sites/default/files/events/Expert%20Workshop/WMO_Megacity_IMP_Plan.pdf)
2. GAW Report No. 208. WMO GURME Workshop on Urban Meteorological Observation Design, Shanghai, China, 11-14 December 2011 (http://www.wmo.int/pages/prog/arep/gaw/documents/Final_GAW_208.pdf)
3. Urban observations, Chapter 11, CIMO Guide (http://www.wmo.int/pages/prog/www/IMOP/publications/CIMO-Guide/Ed2008Up2010/Part-II/WMO8_Ed2008_PartII_Ch11_Up2010_en.pdf)
4. GAW Report No. 205. WMO/IGAC Impacts of Megacities on Air Pollution and Climate (Lead authors: Tong Zhu, Megan L. Melamed, David Parrish, Michael Gauss, Laura Gallardo Klenner, Mark Lawrence, Abdourahamane Konare and Cathy Liousse), ISBN: 978-0-9882867-0-2, 309 pp. September 2012 (http://www.wmo.int/pages/prog/arep/gaw/documents/Final_GAW_205.pdf)
5. Links to urban flood management
Training manuals on urban flood management (http://www.apfm.info/?page_id=894)

Tools for urban flood management issues (http://www.apfm.info/?page_id=677) (http://www.apfm.info/?page_id=778)

Flash flood guidance systems (http://www.wmo.int/pages/prog/hwrrp/documents/FFI/Flash_Flood_Guidance_Systems_Background_Information.pdf)
6. Climate watch advisories (http://www.wmo.int/pages/prog/wcp/wcdmp/index_en.php)
7. CAgM Report No. 90 - May 2003. Agrometeorological Aspects of Organic Agriculture, Urban Agriculture, Indoor Agriculture and Precision Agriculture, by N.M. Holden and M.C. Otiz. WMO/TD-No. 1158. 101 pp. (<http://www.wamis.org/agm/pubs/CAGMRep/CAGM90.pdf>)
8. Integrated Drought Mangement Programme (IDMP) (<http://www.droughtmanagement.info/>)
9. GURME website:

<http://mce2.org/wmogurme/>

10. Climate and Urban Development, WMO-No. 844, Geneva, Switzerland, 1996
11. Weather and Water in Cities, WMO-No. 853, Geneva Switzerland, 1997 (in connection with the World Meteorological Day with the same theme)
12. Weather, Climate and Health, WMO-No. 892, Geneva, Switzerland, 1999