World Meteorological Organization
Vision and Strategy for Hydrology
And Associated Plan of Action

Draft

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PART II: Action Plan

1) Purpose

WMO Members states/National Hydrologic Services/NHMS/UN organizations responsible for other Water programs will collaborate under this Action Plan to implement a strategic suite of enhanced services for operational hydrology to be supported by the WMO by 2030, to achieve the Long-Term Ambitions, thus significantly improving capacity of National Hydrologic Services to deliver enhanced products and services based on cutting edge science and technology.

2) Outputs and Activities by Ambition

The Eighteenth WMO Congress in 2019 approved eight long-term ambitions that should guide the development of WMO activities relevant to water. Each ambition represents a goal that society aims to achieve in the frameworks of sustainable development and disaster risk management. Following section presents major outcomes necessary to reach each of ambition and lists all identified contributing outputs.

2.1 Cross-cutting issues

Little will be done, if the National Hydrological Service is not fully responding to its goals and objectives due to lack of finance, lack of professional staff, insufficient equipment, and more.
Michael Maehaka, consultation on needs and gaps

Gaps identification and consultations made during preparation of this Action Plan revealed that some issues are of clearly cross-cutting nature and are prerequisites to achieve any of eight long/term ambitions. These are related mainly to functioning of National Hydrological Services, including its visibility, financing, sustainability, governance and management. Unfortunately, in some parts of the World, responsible services struggle to maintain long-term monitoring due to limited financial resources leading to patchy (or no) data.

There is a need to extend the outputs and activities to enhance visibility of the NHSs with respective governments to ensure recognition and sustainability (adequacy) of budget allocations for hydrological services. At the same time, sustainability of operations (including monitoring networks, capacity building, personnel stability and training) was identified as a clear prerequisite for any operation and service delivery.

Hand in hand with political recognition comes also data policy set-up. Monitoring, observation and data sharing has been identified as a critical component of NMHSs operations that needs to be enhanced to aim deliver majority of outcomes identified bellow. Downstream and upstream countries in a transboundary basin are in an asymmetric position with respect to data exchange, with downstream countries requiring hydrologic data as well as forecasting products from the upstream countries. On top of that, hydrological/water resources data are sometimes considered to be strategic information and possible subject of international disputes over water impacts. In such a case, the decision on data policy is not at National Hydrological Service level, but at governmental level.

Besides policy issues, technical (easy to use and maintain) capability to effectively exchange data might be limiting factor in international data sharing (communication links, servers, protocols implemented).

At the same time, involvement of hydrological community remained limited in particular to integrated programmes and activities of the WMO like WIS/WIGOS, GDPS etc.

Therefore, following outcomes were proposed to support all 8 long-term ambitions.

Outcomes:

1) National Hydrological Services operations are sustainable, visible for the society and governments, and benefits provided are recognized and valued.
2) Financing schemes of hydrological services are improved to ensure sustainability of operation and attractiveness for professional staff.
3) Increased sharing of hydro-meteorological data for operational hydrology on free and unrestricted basis across political border
4) Increased involvement of hydrological communities of Members in global activities of the WMO and enhanced benefits transfer to national scale services

Metrics: Success in this outcome will be measured by:

1) Number of Members reporting through Country Profile Database sustainable financial (budgeting) situation
2) Number of station registered by Members to reference hydrological network and sharing data
3) Number of Members providing operational and historical data from WHOS (phase II) system
4) Number of experts registered to expert database with hydrology specialization,
5) Number of experts with hydrology expertize involved in working structures of technical commissions and regional associations.

Outputs:

A.1 Increased presentation/ communication understanding of value proposition, benefits and, risk analysis and value of hydrological services to foster understanding by ministries and governments

Hydrological Assembly presents an opportunity for representatives of hydrological community to participate actively in strategic work of the organization. NMHSs will be supported to engage with politicians and better describe values of NMHSs by organizing Regional Associations High Level Fora, leader's coalition and by provision of communication materials and toolkits.

A2 Enhanced regional cooperation, planning and implementation of NMHSs led activities

Regional Associations hydrological activities (e.g. HydroConference in RAVI) and support to other technical symposia will be organized to coordinate on regional hydrological requirements.

A3 Increased management skills of NHSs management (including middle and lower management) supports effectiveness and development of NHSs

Capacity building activities for top and middle management of NMHSs will be prepared including guidelines development, training courses, targeted twinning projects and promotion activities.

A.4 Enhanced customer orientation and better marketing skills generates better services and products with higher added value

Targeting customer orientation skills of the NMHSs by training materials and case studies will help to establish better services, build tighter connections with and increase satisfaction of users of products and services.

A.5 The end-users of hydrological information/data have a clear understanding of what the data means and it's relative (un)certainty.

Developing of unified communication standards for hydrological information based on definition of guidelines and regulatory material to ensure that communication is based on uptake requirements defined by end-users.

A.6 Institution development plans and programmes of monitoring network development are in place and implemented taking into account the catalogue of products and services

Planning of development and operation helps to achieve sustainability of observations and services provided by the NMHSs. NHS providers have the tools to plan and construct hydrological networks that can grow/adapt as needs and resources changes delivered by targeted research. Guidelines on hydrological monitoring network design, implementation and maintenance are available.

A.7 Enhanced resource mobilization (expertise, financial, partnership) for capacity building, technical assistance, training of personnel and sustainability of E2E MHEWS and drought management

Project proposals development support by a framework mechanism to sponsor development initiatives through Project Proposal development and provision of Reimbursable Advisory Services through e.g. the IFM HelpDesk, IDMP, Regional offices and in cooperation with other partners.

A.8 Sustainable projects helps build capacities of NHSs

Capacity development projects in monitoring and data assessment are coordinated across UN bodies and build to support achievement of 8 long term ambitions. Sustainability aspect of the projects is supported by SOFF, use of local resources to maintain equipment, and by standardization & use of open platforms.

A.9 Effective and efficient, low-cost methods for hydrological observations are broadly available

Guidance will be developed on how to amplify the information through citizen science, proxy data, and innovation. HydroHub Innovation hub will stimulate development and deployment of low-cost technologies for hydrometric monitoring.

A.10 Increased availability, national and international exchange of hydro-meteorological data for operational flood forecasting and early warning, and enhanced international cooperation in flood management especially for transboundary basins

To support Resolution 42 and its implementation a network of reference observations is established from which Members commit themselves to mandatory share the data leading to future inclusion of hydrology and cryosphere data to GBON. WHOS will be further implemented for sharing of operational and historical data among Members including demonstration projects on additional types of data (e.g. forecast products from various producers).

A.11 Operational hydrology community at national scale knows how to access the global products, services, tools, activities and community of WMO

Overcoming the input obstacles for hydrologists to WMO activities will be done by developing an 'accueil' directory and will be supported by explanation of benefits for NHSs to become active part of the WMO family.

On-going activities

Given the cross-cutting nature of above listed outputs for enhancement of sustainability of National Hydrological Services and increased data sharing, many of on-going hydrological activities need to be continued and intensified to achieve long term ambitions. **Capacity building in hydrology and water management** and capacity development through projects supported by **APFM** and **IDMP** programmes will be critical for succeed. Governance of National Hydrological Services and its effective operation to deliver high value users' oriented products and services needs to be framed in principles of **Quality management framework – Hydrology**. At the same time, development of observation networks and data sharing demands for continuing advancement of **Hydrological data operation and management** through implementation of **WHOS** and intensified use of **The Global Hydrometry Support Facility (HydroHub)** to stimulate development of technology and methods of observation and data processing.

Assumptions and risks:

We assume that water and hydrometeorological disasters will continue to be considered priority for societal needs both in short term and long term political perspective.

Risks are in possible:

- change in overall political and societal priorities e.g. due to COVID-19 pandemic results decrease the involvement of politicians in water–related agenda;
- lack of alignment with other activities in the field of Water (e.g. UNESCO-IHP) leading to competition for attention of governments;
- Technological game changer undermines the importance and the role of national services.

To be finalized based on consultations

2.2 ambition/goal: No one is surprised by a flood

Lack of trained people and good hydrological monitoring network is the biggest gap in the process of creating flood forecasting and warning service.
Vasko Stojov, consultation on needs and gaps

Floods represents major hydro-meteorological hazards from the point of view of the number of affected people. While the total economic damage caused by floods has tended to increase, flood early warning systems have proved to be an effective tool to decrease the numbers of fatalities. Increased understanding of flood hazard and risk, flood forecasting and warning have enhanced the preparedness and response capacities of nations and communities. Further strengthening of Members' Early Warning systems for floods is necessary to be prepared for future floods and changes in flood hazard and flood risk.

Outcomes:

- Impact based end-to-end early-warning systems (EWS) for flood forecasting in the context of a broader integrated flood management strategy implemented by Members.
- Public, communities and businesses have enhanced access to and better capacity to react to official national hydrological forecasts and warnings globally and locally.

Metrics: Success in this outcome will be measured by:

1) Number of Members having Multi-hazard Early Warning System set up for floods (at least 80 % of Members declared substantial or comprehensive achievement for all 4 major components of EWS for floods in Sendai Monitor of UNDRR).
2) Number of Members providing their flood warnings via GMAS (at least 50 % of Members doing so)

Needs and gaps

Floods are the most important nature disasters and are a result of combination of various phenomena and processes. In consequence, many WMO programs and activities address floods in a certain way, what means a challenge for effective coordination.

Gaps and needs of National flood forecasting and early warning system are not identified in a consistent and organised way. Additionally, there's a lack of expertise to design and development of a flood forecasting and warning system in some regions and low standardization of data flows and methods of operation makes it difficult to transfer solution easily, including language barriers.

Flood risk assessment process (tools) is not available or not fully understood by all Members. In some countries, collaboration between NHSs, NMSs, and other authorities involved in flood forecasting (National DRR Authorities) towards the creation of Multi-hazard early warning system (MHEWS) is not effective enough. Sometime, processes in flood early warning are understood as sequential steps where components of MHEWS (risk knowledge; monitoring and forecasting; dissemination; capacity to respond) are dealt as completely separate issues without considering the whole value chain. Such discrimination of actions might lead to in-effectivities at interfaces and lack of coordination. A special importance

should due to flash floods that demand for different approaches ad tools to be used for efficient early warning.

Financial resources are limited, both at national and international level to realize all necessary development projects around the World. Additionally, after the investment, lacking resources for operation and maintenance (sustainability) are often a reason for failure, degradation or sub optimal functioning of developed systems.

Sharing of data in near-real time remains a challenge in some parts of the Word. Use of global coverage products (satellite, NWP, hydro models), despite its huge development over last few decades, remains limited in operational hydrology (likely due t data policy, IT connection, lack of knowing where to search, etc.). When using global products, quantitative interpretation is often needed, but access to basic data (of hydrological meaning) at reasonable scale is rarely available. Experience also shows that majority of Members have some gaps in conveying forecast and warning information to users, which results in decrease of effectiveness of forecasts and warnings.

In a wider scope, a flood protection sometimes neglects Integrated flood risk management principles. Considering development of end-to-end early warning system without a context of other components of flood protection (land-use planning, reservoir operation, response planning etc.) leads to conflicts and inefficiency where holistic approach is not applied.

Outputs:

B.1 Enhanced coordination, effectiveness and governance of all WMO activities in supporting Members in Flood Risk Assessment and Flood Forecasting and Warning

Flood Forecasting Initiative will be reinforced as coordination mechanisms of activities for Flood Risk Assessment, Forecasting and Warning across WMO. Effective joint planning and implementation mechanisms must be initiated with major partners and activities (e.g. IFI, UNDRR), similarly WMO will seek for principles of cooperation with private sector in this issue.

B.2 Framework is developed for evaluation of gaps and needs of National flood forecasting and early warning systems

Assessment Guidelines will be developed, completed by community supported web based tool for self-evaluation.

B.3 Increased exchange of knowledge and technical expertise in flood forecasting among Members

Knowledge transfer will be realized through Community of Practice on End-to-End Early Warning Systems for Flood Forecasting, including guidance on emerging technologies and services for data acquisition and analysis.

B.4 Enhanced collaboration among NHSs, NMSs and other organizations (e.g. DRR authorities) at national level in developing and operating E2E MHEWS particularly including floods

Support will be provided for inclusion of different stakeholders' requirements (energy-water-food) by compilation of success stories for collaboration among NMHSs and DRR authorities. Promotion of MHEWS approach (e.g. with the integration of FFGS/CIFI/SWFP) for integration of hydrology in GMAS (including humanitarian support and reflecting hydrological hazards in the catalogue of hazardous events) by explaining concept of EWS and showcasing benefits of coproduction of MHEWS services between communities.

B.5 Increased availability and international exchange of hydro-meteorological data for operational flood forecasting and early warning, and enhanced international cooperation in flood management especially for transboundary basins on free and unrestricted basis.

See A.10

B.6 Enhanced resource mobilization (expertise, financial, partnership) for capacity building, technical assistance, training of personnel and sustainability of E2E MHEWS

See A.7 (Project proposal development will be supported by a framework mechanism to sponsor development initiatives through Project Proposal development and provision of Reimbursable Advisory Services through the IFM HelpDesk.)

B.7 Flood related data and products with global and regional coverage are available for the use at national scale by Members

Establish RSMC centers with function in the field of operation flood forecasting within GDPFS to support Members with global and regional product and verification. Develop inventory of world- wide and regional free and public data and products for Flood forecasting; and inventory of international interoperable models and platforms.

B.8 Increased Members' capacities to communicate to the public and raising the awareness

Set of guidelines, best practices and training materials will be prepared including CAP application to hydrological hazards, communication of uncertainty, impact based forecasting, and communication with users on their requirements as well as on interpretation of forecasting results and related risks.

B.9 Increased Members' and Regions' (basins) application of integrated flood risk management principles in flood prevention, preparedness and response.

Continuing APFM activities in capacity building in integrated flood management

On-going activities

The **WMO FFI Flood Forecasting Initiative** and **APFM** has been the major contributions to flood related disaster risk management activities that need to continue and further develop in order to achieve long-term ambition 'no one is surprised by a flood'. Relevant activities needs a continuing support by **Capacity building in hydrology and water**

management, which helped increase capacities of Members in flood risk assessment and flood forecasting and warning in previous years. However, reliable flood forecasting service can be built only if **Hydrological data operation and management** provides sufficient (amount, quality, resolution) data and **Quality management framework – Hydrology** properly address users' requirements and helps establish and maintain processes to deliver products and services

Assumptions and risks:

We assume that water and hydrometeorological disasters will continue to be considered priority for societal needs both in short term and long term political perspective.

Risks are in possible:

- Change in overall political and societal priorities e.g. due to COVID-19 pandemic results in decreased involvement in water–related agenda
- COVID 19 pandemic is altering WMO modalities of work, with a potential impact on efficiency due to teleworking and impossibility of face-to-face meetings.
- Lack of alignment with other activities in the field of Water (e.g. UNESCO-IHP) leading to competition for attention of governments.
- Technological game changer undermines the importance and the role of national services in flood forecasting
- In case of community of practice, also in insufficient contribution from Members and competition of other communities of practices outside WMO for resources (mostly human)
- In case of GDPFS, lack of candidates to become centers operating under GDPFS rules and development of centers outside the umbrella of GDPFS (including in private sector) that undermines the idea of GDPFS as well as lack of acceptance of the GDPFS hydrology structure by NHSs
- Lack of financial resources for core activities of the Secretariat

To be finalized based on consultations

2.3 ambition/goal: Everyone is prepared for drought

I believe, we can start somewhere and we can start simple. Ram Dhurmea, consultation on needs and gaps

Although drought can cause water and food shortages, impact the health of the population (including increased morbidity and death), and have socio–economic and political consequences, many drought-affected countries do not yet have national drought policies or existing policies may need to be updated; countries need further assistance in enacting policies that incorporate the three pillars of drought management (monitoring and early warning systems, vulnerability and impact assessments, and mitigation and response measures).

Drought is a complex phenomenon connecting meteorological, climatological, hydrological and other communities to support resilience of communities and nations by provision of data and information on drought including precipitation, low-flow, groundwater, soil moisture, lakes and reservoirs, water withdrawal, etc. WMO activities support Members drought preparedness, using (for instance) current capabilities in seasonal to multi-year climate forecasting or drought risk assessment.

Outcome: Members implemented systems for integrated drought management covering drought monitoring and early warning, drought vulnerability and impact assessment & drought mitigation, preparedness and response reduce adverse impacts of drought at all levels.

Alternative wording: Enhanced drought management systems comprising drought Monitoring and Early Warning & drought vulnerability and impact assessment & drought mitigation, preparedness and response implemented by Members

Metrics: Success in this outcome will be measured by:

- Number of Members providing their drought preparedness, monitoring and assessment products and services that includes water resources (hydrological) component available through WMO infrastructure (RCOFs, GMAS, HydroSOS)

Needs and Gaps

Members sometimes struggle to establish strategy and process to enhance their drought management systems including drought monitoring and assessment. It is usually expected that National Hydrological Service provides products for drought-related decisions on a seasonal scale. But, capacities to run seasonal drought-related forecasts at Members' level are often not available. That includes a fact that it's difficult to reach users to understand their needs and requirements. Successful drought risk assessment needs close cooperation between hazard community (met-hydro) and impact community (agronomy, DRR, etc.), which often lacks functional platform at national scale

On top of that, developing drought policies and establishing drought management systems, insufficient amount and quality of data perform drought hazard, vulnerability and risk assessment is an obstacle. Despite substantial progress in remote sensing methods and Earth system modelling, drought related data/estimates from satellites are not well verified on the ground; access to global (satellite and other) products is limited – due to data policy,

limited broadband, or lack of know-how. In addition, graphical products are not enough – some consequent quantitative interpretation is often needed, but access to basic data (of hydrological meaning) at reasonable scale is often not available. Similarly, climate (seasonal) forecasts are not always detailed enough (e.g. global products are not easily accessible in quantitative form at useful scale) to be of use for sound hydrological interpretation at national or subnational level. There's also a challenge in building thrust in seasonal products through demonstration of its benefits for water management.

When designing and implementing capacity development projects, coordination remains suboptimal in some activities both at national level as well as global level (FAO, WMO, UNESCO) leading to duplication or implementation different tools and systems in one country resulting in obstacles for operation and maintenance. Critical seems to be sustainability of projects after first few years is questionable (investment costs of projects are secured, but financing of maintenance and operation may fail).

Training of experts in various aspects of drought managements and their support through community of practice and provision of tools and methods remains a challenge for future years.

Outputs:

C.1 Enhanced coordination, effectiveness and governance of all WMO activities in supporting Members in Integrated Drought Management

Streamlining of ongoing activities on Droughts across the WMO Constituent and Subsidiary bodies will ensure coherence, consistency, and efficient use of resources, building on IDMP continuing Community of Practice and a HelpDesk. Building of partnerships for effective joint planning and implementation mechanisms with major partners and activities (IDI, UNDRR, FAO, IFAD, etc.) as well as with private sector to support drought risk management.

C.2 Drought related data and products with global and regional coverage are available for the use at national scale by Members

Drought related GDPFS centers support NMHSs to process and apply the information to local context. Initiating from identification of requirements from NHSs on globally/regionally produced information for use in drought assessment, modelling and prediction at national scale by NHSs an interface, guidelines and training materials for NHSs will be developed to search, use, interpret and verify products.

C.3 Gaps in Members capabilities in drought assessment, monitoring, modelling and prediction are known

Checklist to enable reviewing current capacities of Member will be developed within the framework for evaluation of gaps and needs of National drought forecasting and early warning systems.

C.4 The need of an effective national drought policy is understood by Members

Support to Members in developing proactive drought impact mitigation, preventive and planning measures (within the frame of local/national development policies), and risk management, improve the public awareness of drought risk and preparedness for drought.

C.5 Increased capacities of Members through training of personnel in drought (low-flow) Monitoring, Modelling and Early Warning & drought vulnerability and impact assessment & drought adaptation and mitigation, preparedness and response

Capacity building activities related to drought management will be organized through the IDMP and regional cooperation, including development of curricula and training material based on Members' needs identification; and support to twinning projects in user driven drought-related products development.

C.6 Increased capacities of Members through development projects in the area of Monitoring and Early Warning & drought vulnerability and impact assessment & drought adaptation and mitigation, preparedness and response

See A.6

C.7 Increased cooperation (and co-production of services) of hydrological, meteorological and climatological communities and international exchange (e.g. higher involvement of hydrology in climate outlook forums, basin commissions)

Increased co-production of services at regional level through implementation of water segment with RCOFs to provide complete outlooks on climate and water availability to users. Regional Associations produce regular (annual/seasonal/monthly) statements on water resources.

C.8 Increased Members capabilities in drought vulnerability and impact assessment of different sectors by meaningful drought indicators and indices used at all relevant scales.

Development of Global Drought Indicator (GDI), including a water scarcity and other hydrological indicators will be supported by development of guidelines on harmonizing drought early warning and risk information for end user communication.

Ongoing activities

Integrated drought management programme (IDMP) has been developed to support activities in drought/related disaster risk management across WMO domains. Recently, hydrological community has started development of contribution to drought management through designing and promoting the **WMO Global Hydrological Status and Outlook System (HydroSOS)**. As for other ambitions, **Capacity building in hydrology and water management** and **Quality management framework – Hydrology** traditionally

helped in establishing services at Members and basin levels supporting drought management activities.

Assumptions and risks:

We assume that integrated drought management is a priority at national level for Members.

Risks are in possible:

- Change in overall political and societal priorities e.g. due to COVID-19 pandemic results in decreased involvement in water–related agenda
- COVID 19 pandemic is altering WMO modalities of work, with a potential impact on efficiency due to teleworking and impossibility of face-to-face meetings.
- Lack of alignment with other activities in the field of Water (e.g. UNESCO-IHP) leading to competition for attention of governments.
- In case of GDPFS, lack of candidates to become centers operating under GDPFS rules and development of centers outside the umbrella of GDPFS (including in private sector) that undermines the idea of GDPFS as well as lack of acceptance of the GDPFS hydrology structure by NHSs
- Lack of financial resources for core activities of the Secretariat

To be finalized based on consultations

2.4 ambition/goal: Hydro-climate and meteorological data support the food security agenda

Resolving the equation of water demand for human consumption, irrigation requirements, water availability and potential water storage needs support as well as providing advice to optimise rain-fed and irrigated agriculture. A multidisciplinary approach, by integrating the agrometeorological, climatological and hydrological expertise with economic and geophysical data and water resources practice, should be developed.

Outcomes:

1) Food security is enhanced by informed end users' decisions at all levels from regional to local.
2) Concept of Integrated water resources management including water use and allocations for supporting food production is widely accepted and followed

Metrics: Success in this outcome will be measured by:

1) Decreased number of famine/hunger emergencies due to drought and water scarcity (in 2021-2030 relative to 2001-2020).
2) Number of members monitoring and accounting for water consumption in their water budgets at basin scale

Needs and Gaps

Drought and floods with other hazards were historically the most common causes of food insecurity. While droughts remain at center of focus when speaking about food security, wider understanding to processes and feedbacks within water-food-energy nexus is needed to enable water management support food production in general. Water is understood to be a strategic commodity by some countries and so is water and hydrological data that remains unshared.

Successful agrometeorological and climatological products and services were developed in past decades to support rain-fed agriculture, like RCOFs. Hydrological data, products and services need to complement these, in particular, in regions where production depends on irrigation ad water allocation schemes depends on water availability and its predictions, concerning both surface and groundwater.

Users' needs and requirements are critical substance in developing and delivery of products and services. In this aspect, there's no universal solution, as priorities and preferences of the society are different in different parts of the World. On the other hand, benefits of hydrometeorological services for food production can be easily demonstrated and assessed on yields.

At global level, coordination of development projects and cooperation in operational activities needs to be ensured with relevant partners, in particular FAO and WFP

Outputs:

D.1 Increased production and availability of agrometeorological and hydrological forecast from sub-seasonal to seasonal

Methodology and tools will be developed to interpret HYDROSOS data and information for agricultural applications (including snow, ice, soil moisture, groundwater, irrigation, water storage). Review of available and reliable methodologies to be used for specialized applications of seasonal forecasts will be done as initial step to decide on further actions in supporting of sectors such as inland navigation, energy, or health by specialized outlook products.

D.2 Effective dialogue between users and providers established

Guidelines based on good practices on dialogues with users will assist Members to establish consultation platforms and communication with users, including research on user requirements and expectations, case studies of product and service development, marketing strategies, and processes to support strategic service planning of NMHSs (including e.g. catalogue of products and services).

D.3 Strengthened capacity of NMHSs personnel in user driven product and services design and delivery (in the field of support of food production and security)

See C.5

D.4 Water-food-energy nexus and ecosystem services are better understood and inform water resources management

Activities will facilitate discussion on the role of hydrology in providing the required data for optimizing the management of water resources to accommodate the three sectors' needs; through symposia, open panels, TED talks, or case studies on the water food energy nexus.

On-going activities

Food security is closely connected to water resources availability and droughts, therefore again **Integrated drought management programme (IDMP)** might be seen as major contributing activity in this regard together with continued implementation of the **WMO Global Hydrological Status and Outlook System (HydroSOS)** and relevant activities in the frame of **Capacity building in hydrology and water management** targeting development and operation of food/production relevant services at Members' level.

Assumptions and risks:

We assume that integrated drought management is a priority at national level for Members.

Risks are in possible:

- Change in overall political and societal priorities e.g. due to COVID-19 pandemic results in decreased involvement in water–related agenda
- COVID 19 pandemic is altering WMO modalities of work, with a potential impact on efficiency due to teleworking and impossibility of face-to-face meetings.
- Lack of alignment with other activities in the field of Water (e.g. UNESCO-IHP) leading to competition for attention of governments.

- In case of GDPFS, lack of candidates to become centers operating under GDPFS rules and development of centers outside the umbrella of GDPFS (including in private sector) that undermines the idea of GDPFS as well as lack of acceptance of the GDPFS hydrology structure by NHSs
- Lack of financial resources for core activities of the Secretariat

To be finalized based on consultations

2.5 ambition/goal: High-quality data supports science

Globally accepted and free accessible data infrastructure is lacking – monitoring data from NHSs and research is not brought together. Harald Köthe and Stephan Dietrich, consultation on needs and gaps

The interoperability between science and data generates knowledge and progress. The value of data accessibility, usability and reliability has been proved to be a strong driver for the science development.
Mandatory data availability policy has been established and enforced in some sectors, but increased contribution is still needed to establishing common standards and policies for data management and sharing, to support generation of high-quality hydrometeorological data and corresponding information products and services for research and development.

Outcome: Increased discoverability, availability, and use of high-quality hydrometeorological and hydrologic data for scientific analysis

Metrics: Success in this outcome will be measured by:

- Number of discharge time series with data available for 2021-2030 period that are accessible via WMO infrastructure and programmes (such as WIS, WHOS, GRDC) for scientific purposes on free and unrestricted basis.

Needs and gaps

To ensure production of quality data, concept of QMF-H was developed and promoted by the WMO, however it is likely still not well understood or not considered to be a priority by all Members. Materials and guides are not easily implementable (including language barrier) or implementation cost is too high.

At the same time, variety of hydrological conditions and regimes is extreme, finding one fit-all solution for hydrological observation standardization and quality control procedure is a challenge. In addition, differences in development and capacities among members are great – application of methods from developed countries might be too demanding for some developing Members, while in opposite, too benevolent methods might not suite countries with developed monitoring programmes.

Exchange of data for scientific community remains limited at global level, due to restricting data policies of some Members, but also due to lack of flexible, easy to use technical platform. In addition, research community requirements on data (and its characteristics) is not always well defined and may differ from day-to-day operational needs.

Research institutes and operational agencies under certain conditions compete for resources – both financial (funding) and human. It is usual that NHSs perform some research activities, with increased competition of larger research teams, work at the NHSs might be feared to degrade to routine operation only which would mean decreased motivation for staff and decreased prestige for the institution. This competition might be overcome by balanced partnership and mutual cooperation on applied research. Similarly, combination of data from long-term in-situ observing networks with short research observation, experimental data, and other sources of information (e.g. satellite) to 'one stock' is opportunity for better cooperation towards shared goals.

Outputs:

E.1 Methods for standard assessment of data quality developed

Guidelines on assessment and flagging of hydrological data reflecting its quality will be develop, including development of practical methods for such assessment. Continuous process of revise and updating of Technical Regulation Vol. III will be initiated targeting in particular the Annex on Hydrometry. Other hydrology related materials/documents will be revised for QMF-H compliance.

E.2 Quality assured hydrometeorological data by NHSs are generated through increased compliance to the culture of Quality Management Framework - hydrology (QMF-H)[1]

Activities will support Members to achieve QMF compliance by development of generic data production processes (schemes), metrics and internal guidelines for easy customization for NMHSs. Training materials and e-learning on QMF will be produced, including basic field safety manual/training course. Members will be encouraged to implement QMF by information highlighting the benefits of QMF.

E.3 Improved development and maintenance of technical platforms to support data discovery and accessibility for exchange for research and science

Integration of hydrological networks to relevant WMO platforms through implementation of WHOS. Role of existing global datacenters will be redefined to better support needs of Members in data sharing and joining WIS/WIGOS, including sharing of data from research basins and projects by academia.

E.4 Improved coordination on observing networks to fit the research purposes

Based colloquium/conference on data for scientific purposes that would identify what and how to measure to enhance scientific progress of hydrology - a concept paper for jointed distributed hydrological laboratory will be developed for further consideration.

E.5 Enhanced culture of research & development projects co-design and joint management (operational hydrology and academia)

See F.1

On-going activities

Quality management framework – Hydrology has been promoted as key principle to ensure production of high quality and quality controlled data for various purposes including research. As measurement technology developed, **Assessment of the performance of**

[1] Quality Management Framework - Hydrology goal is to provide strategy, advice, guidance and tools for the National Hydrological Services to attain quality, efficiency and effectiveness in their functioning. As such it provides documentation on approaches to Quality Management System (QMS) and guidance on its adoption and implementation by NHSs; documentation and guidance on management of NHSs; documentation on technical approaches for the provision of hydrological data, products and services; and development of training modules and materials.

flow measurements has become a major initiative to support National Hydrological Services in correct and effective use of new equipment in everyday operation. It needs to continue support hydrologist by guiding on methods of hydrometric measurements and its quality assessment. At the same time a need for new possibilities of measuring data, where conventional methods are not available or too expensive, was recognized. **The Global Hydrometry Support Facility (HydroHub)** has been initiated in response helping developing Members to increase number and reliability of observations. The **WMO Hydrological Observation System (WHOS)** ensures hydrological data operation and management in the frame of WIS/WIGOS with foreseen continuation of its implementation (phase II).

Assumptions and risks

To be finalized based on consultations

2.6 ambition/goal: Science provides a sound basis for operational hydrology

The responsibility for operational services needs to be based on the state of knowledge of the water resources and the current and foreseeable pressures on them. The fundamental research on the other hand needs to be tailored to user needs, in an applied research approach. Earth system science in an integrated perspective broadens the hydrological perspective and the advancement of hydrological science.

Outcomes:

- Reduced gap between research and operational hydrology applications; operational hydrology uses improved understanding of Earth system science
- There is a greater understanding of how the hydrological system responds to extreme conditions

Metrics: Success in this outcome will be measured by:
Number of WMO (co-)sponsored research programmes/projects that includes implementation of operational hydrological applications at Members' level during 2021-2030.

Needs and gaps

Gap between research and practice paradoxically increases. One of the reasons is that NHSs are not always recognized as beneficiaries (clients) and users of research results. It points to possible weak customer orientation of some research teams towards operational services, and to limited understanding the production/value chain from meteorology/climatology to hydrology/water management in case of research topics stretching over scientific domains. Obviously, a separation of scientific and operational communities is recognized as a problem that needs to be overcome by closer cooperation and twinning. It is agreed that enhancement of operational hydrology demands for an interdisciplinary approach not limiting the scope to hydrological sciences.
Among identified research needs for operational purposes, there is an urgent need for inexpensive sensors and telemetry, cloud based platforms and free satellite data reception. Satellite observation and other emerging types of data are a promising source of information but demand for calibration and ‚merging' with in-situ observation. It is also recognized that the science of Earth system has developed significantly over last decades, yet the transfer to practice lags behind in many parts of the World. Due to extreme dynamic of research, it has become impossible for practitioners from NHSs to observe, research, follow and use all relevant products and outputs. In addition of those operational products available, few fits hydrological needs on resolution (basin scale), sets of parameters, frequency of data, formats, etc. A big challenge for use of meteorological and climate data for hydrological applications remains fact that without bias correction water balance might be disturbed, but bias corrected data do not always keep the physical sense.

Outputs:

F.1 Enhanced culture of research & development to operation projects co-design (by operational hydrology and academia) - (Demonstration) projects are developed with beneficiaries being National Meteorological and Hydrological Services

Implementation of research strategy for hydrology in the frame of overall WMO research programme will help closing research to operation gap (including close cooperation with UNESCO-IHP and IAHS). It will be supported by developing a catalogue of case studies/best practices for cooperation for direct enhancements of NHSs operations by targeted/customized research and continuous updating of database of research needs from NHSs as a project topics repository for scientist.

F.2 Enhanced collaboration between hydrology and meteorology communities of practice, including academia

See B1.4 and B2.7

F.3 Inventory of the compiled data and products from Earth systems science projects for hydrological applications

See B0.11, B1.7 and B2.2

F.4 Improved Earth system models at high resolution for local and regional applications

NHSs have the tools to assess and predict the current and future state of the water resources. Information is available to fully integrate surface and groundwater resources to improve earth system modelling and forecasting, in particular QPE and QPF.

F.5 There is a greater understanding of how the hydrological system responds to extreme conditions

Tools and modules to assess and analyse uncertainty of extreme conditions are available. Research community further develops uncertainty and scenario analysis that can be directly used to design/manage infrastructure & water systems.

On-going activities

Assessment of the performance of flow measurements represents an example of applied research transformation for the benefits of operational hydrology by evaluation performance and uncertainties associated with new technologies for flow measurement. In a broader scope **the Global Hydrometry Support Facility (HydroHub)** is intended to stimulate applied science for operational hydrology through development of new methods, instruments, and tools for practice. In the field of floods, several research demonstration projects were developed within the frame of the **WMO FFI Flood Forecasting Initiative**. However, in the field of hydrology, research belongs to responsibility of the UNESCO-IHP at the UN level. Therefore cooperation and coordination of research activities would be necessary with external partners including UNESCO-IHP and IAHS through Hydrological Coordination Panel and Research Board.

Assumptions and risks

To be finalized based on consultations

2.7 ambition/goal: We have a thorough knowledge of the water resources of our world

Collecting, managing and sharing data on water resources and uses, (all the key variables associated with operational hydrology) are fundamental for a better understanding of resources and developing appropriate water management solutions, informing the decision-making process, from local to global scale.

Despite the advances in technology and policy, we are far from having comprehensive information on the state of water management across the world, nor featuring major characteristics, trends, constraints and prospective changes.

Regional analyses need to be supported by systematic, up-to-date and reliable information on water and to serve as a reference for large-scale planning and predictive studies.

Outcome: Members implemented reliable water resources assessment systems to deliver and share information on water resources availability

Metrics: Success in this outcome will be measured by:

- Number of Members providing their water resources assessment through HydroSOS, or other WMO regional systems.

Needs and gaps:

Many Members, especially in the developing countries require investment and support to build the skills, tools and infrastructure (hydrological and meteorological monitoring networks; framework and IT infrastructure for data curation, archival and retrieval systems and quality assurance) needed to enhance their NMHS's capacity to transform hydrological and meteorological observations into actionable water resources information. That includes investment in reporting framework (including use of common standards) for hydrological status and outlooks information and human capacities to develop and operate it.

As a result of above mentioned, access to water resources assessment information for general public and for advanced users with contextualization is missing. To develop it, integration and coordination between climate and hydrology community of practice would be necessary. Improved water, food, energy security and public safety requires due consideration of the river basin scale, but at the moment, there's lack of methods for blending high resolution datasets of streamflow, gauged rainfall, lake levels, soil moisture and evaporative demand at hydrologic relevant scales.

What is missing at the moment seems to be a 'catalogue' of hydrological tools describing capabilities and credible information on fit for purpose nature of the tools and investments warranted by member states NHSs for their adoption and use. There's also a need for capacity building in hydrological modelling technologies and prediction systems that focus on resolving weather and climate to hydrology problem for empowering Member states to develop decision support systems to manage water supply and demand pressures.

In some cases, NMHSs struggle to understand stakeholders' and users' needs due to limited communication and cooperation (connection to) these communities. Water resources management needs to be framed in well-developed planning processes at various levels and well linked to assessment of its impacts and benefits.

Outputs:

G.1 Current status/assessment of water resources is available at different spatial and temporal scales and covers variability of products including e.g. snow, groundwater, lakes, and reservoirs

Increased and enhanced water resources assessment activities performed at national scale will provide inputs to the HydroSOS at global scale. HydroSOS will be implemented in line with implementation plan.

G.2 WMO community informs high-level policy discussions at global scale

Based on Concept note, format and specification of general hydrology advisory will be developed and later implemented (including building support network/structure for production for regular production.

G.3 Data, products and model results, at adequate spatial and temporal resolutions, are available for actionable planning and operations at the local scale

WMO will develop a system of GDPFS centers that produce data and information specialized to support water resources assessment of Members, based on their requirements. Members will be provided with training materials and tools if needed to interpret GDPFS products for national and local applications for WRM.

G.4 Increased national capacities to collect water-related data and transform them to useful/relevant products through capacity building (The staff of NMHSs understands the societal impacts of water and water resources management plans and decisions, the importance of water resources assessments for various stakeholders, and is well informed on the technologies available for them to best carry out their tasks and are expert in those that best suit their key applications)

Compendium of societal, economic and ecologic relations/dependency on water/hydrological cycle will be developed based on review of existing studies, synergising and collating information. Community of practice for water resources assessment will support NMHSs including support to apply available tools and products, helps in selection of proper methodologies and tools for WRA by Members (including support to twinning projects between Members targeting water resources assessment and water resources management). Training curriculum for WRA will be developed as a part of capacity development strategy of the WMO. Based on curricula, courses and training materials will be developed. WRA 'manual' will be published.

On-going activities

Historically water resources have been considered at national or basin level mostly. **The WMO Global Hydrological Status and Outlook System (HydroSOS)** is implemented as critical activity in the field of assessment of water resources at global and regional levels. Its implementation will be enabled by enhancement and implementation of **WHOS** and will be supported by continued **Capacity building in hydrology and water management**.

Assumptions and risks

To be finalized based on consultations

2.8 ambition/goal: Sustainable development is supported by hydrological information

The availability of hydrological information does support all water–dependent sectors for optimal water resources management as well as for planning and adapting to transient environmental conditions. Majority of goals of the UN sustainable development agenda have connection to water, therefore hydrological information is important for monitoring and assessment of SDGs.

Outcome: Hydrological information of adequate resolution, quality and timeliness is available and being used for informed decisions on sustainable development at all scales.

Metrics: Success in this outcome will be measured by:

- Number of Members including hydrological aspects and water budget information to their development plans at national level.
- Number of Members reporting on SDG using reliable hydrological data and indicators

Needs and gaps:

When speaking about sustainable development agenda, it seems that lack of awareness of the central role of water in SDGs and need for integrated actions prevails in the community of operational hydrologists. So far, there was no need for creation of variables that are monitored by hydrological services for the purpose of international SDG monitoring. In some countries, understandably, priorities are in delivering of flood and drought warnings and developing capacities in these fields, while creation of information and products is second order priority at the moment. If such variables are developed, we may face hesitation to send data to be stored somewhere else for global purposes and back-up.

Outputs:

H.1 Improved data policies, financing schemes, and enhanced political arrangements to collect hydrologic data and derived products

Implementation of resolution on data policy will be supported by development of the reference network for hydrology and recognition mechanism of centennial station in hydrology to highlight the importance of sustainable contribution.

H.2 Intensified national, basin, transboundary and international cooperation and activities to meet SDG

Output will be delivered by supporting the building of national, basin and transboundary partnerships for WATER SDGs by compilation of success stories. At global level, partnership with FAO and UNESCO will be established to develop a plan for hydrological data/information/products collection for support of the SDG. For that purpose, definition of set of parameters to monitor and support sustainable development on a long-term scale is foreseen.

H.3 Basic tools to assist members are created, including an archive of relevant information, tools for transforming data to information, and maintenance of essential "treasury/heritage" variable to support SD

Concept note/feasibility study will be developed to assess possibility to develop WMO hydrology cloud for storage of essential data of Members for consideration of CG and potential implementation. Sharing of data from recognized centennial/reference network will be supported leading to implementation of GBON for hydrological domain. SW (or cloud solution) for computation of parameters for support of SDG, including its web presentation.

On-going activities

The World Water Data Initiative aims to reply to needs of sustainable development implementation in the field of water/hydrology information. While concrete tools and activities targeting sustainable development has not been fully developed yet by the WMO community, obviously the **WMO Global Hydrological Status and Outlook System (HydroSOS)**
Will be the central activity in this regard supported by **Hydrological data operation and management** infrastructure.

Assumptions and risks

To be finalized based on consultations

2.9 ambition/goal: Water quality is known

Without water quality information, the decisions made on the use of the water resource will be partial and biased.
José Alberto Zúñiga, consultation on needs and gaps

Outcome: (At national level) increased cooperation and water quality data exchange.

Water quality is integral part of the water cycle. The monitoring of surface and groundwater quality is a necessary condition for the basic requirements of society and ecosystems, and the possibility to adopt timely corrective solution whenever needed.

Metrics: Success in this outcome will be measured by:
Number of Members running water quality monitoring programmes and performing water quality assessments.

Needs and gaps:
The main gap in water quality assessment is limited awareness of society and politicians of the need for water quality assessment resulting to limited financial resources for this field and missing coordinated and integrated monitoring programme in water quality in some member countries. Water quality monitoring is technically and financially demanding and at many parts of the World it has not become a priority in situation of limited resources. This might be connected to missing or limited understanding of principles of Integrated water resources management and interconnection of all water related processes at decision making level as well at level of relevant institutions.
It is often a different authority, other than Hydrological Service, that bears responsibility for water quality (and related health issues). In some cases, functional partnerships of responsible organizations at national/regional level has not been established yet. In the past, there's been a lack of impetus for majority of hydrological service to start their involvement in water quality monitoring resulting in limited coordination between quantity and quality monitoring networks and separate assessments of quality and quantity aspects of water.
At WMO, water quality has not been considered relevant domain so far, mostly due to missing demand form Members' level – from National Hydrological Services. While basic cooperation with UNEP, UNESCO-IHP and WHO exists, limited knowledge of programmes and activities from outside of the WMO (like GEMS) to National Hydrological Services prevails. In addition, development projects are usually not designed as joint quantity-quality solving complex projects. A need to cooperate with existing water quality activities at global level, in particular with UNEP GEMS, is well recognized. At the same time, there are no internationally agreed standards for exchanging water quality sampling data and exchange of water quality data is limited – likely also due to various responsibilities at national scale in the field of water quality.

In consequence it seems that scarcity of WQ data, even in major water bodies (surface and underground), doesn't allow to perform environmental baseline studies required for Environmental Impact Assessment and Environmental Management Programmes of engineering projects etc. And finally, unavailability of water quality data limits applicability and enforcement of relevant environmental policies and regulations of industrial/domestic effluents.

And i tis a lack of water quality standards (limits) for ambient water quality that is seen to be limiting for effort of many member states. Similarly, more guidelines are demanded to help develop water quality monitoring programmes at national level differentiate among surveillance monitoring (for regulatory or enforcement purposes) with systematic monitoring of water quality (long term changes) nor with alarm systems for pollution accidents. All of these are important but serves different purposes and involve different stakeholders. The role of National Hydrological Service and the WMO seems to be most prominent in systematic monitoring of specific parameters. Finally, it is recognized that sediment load demands for specific attention, in particular with respect to reservoirs.

Outputs:

I.1 Partnership at UN level exists and promotes provision of WQ data from NHSs to existing information systems (such as GEMS, IIWQ, ISI)

Responsibility on Water Quality at UN level is shared between WMO, UNESCO and UNEP. Establishing WMO-UNEP-UNESCO partnership or coordination mechanism on water quality building on the World Water Quality Alliance is a key to enhance availability of water quality information at global level and increase the effectivity of development activities through a joint work plan. Existing systems (WHOS, GEMS, IIWQ) needs to be interconnected to share and exchange data in standardized formats and procedures.

I.2 Increased NHSs involvement in co-production of water quality related data and products thanks to promotion of IWRM principles.

Not all NHSs holds responsibilities in the field of water quality currently, but water quality aspects are becoming more important in the frame of the SDGs and thus monitoring and assessment are being developed by Members. Activities aim to support building of partnerships for water quality at national and international basin scale, to support formulation of the National Water Quality Management Strategy, Action plans and Monitoring Programs including data policies. Based on identified needs water quality training materials will be developed.

I.3 Increased joint water quantity and water quality assessment (monitoring and modelling) for operational management and for planning

Review of state of operational monitoring, modelling and assessment of water quality at Members and basin level and its systematic update will inform other activities on needs and gaps at Members level and will help to develop joint WMO-UNEP-UNESCO strategy to increase availability of water quality assessments from Members and on international basins. A concept paper for inclusion of water quality to HydroSOS will be developed for further consideration of WMO water community.

I.4 Water quality aspects are included in country support activities/projects in the spirit of IWRM and in cooperation with other organizations

Water quality determines availability of water resources just as water quantity. Both needs to be considered adequately in development projects to ensure successful enhancement of Members abilities to manage water resources ad achieve SDGs. Through the partnership with UNEP, UNESCO, UNDP and WB a definition of minimum requirements/checklist for water quality aspects to be included in country support activities will be developed and applied.

I.5 Partnership at UN level delivers co-produced guidelines related to water quality

WMO-UNEP partnership will gather an expertise to develop consistent guidelines for water quality monitoring and assessment for the use of responsible authorities at national level.

Most prominently to develop and update Technical Regulation Vol. III – hydrology Annex on water quality.

On-going activities

Water quality has been underdeveloped domain among WMO operational hydrology activities so far. While it has been partly considered within **Quality management framework – Hydrology** documentation, it's obvious that most lot has to be done in **Capacity building in hydrology and water management**, **Hydrological data operation and management** needs to be accommodated to water quality information processing. There's a great potential to benefit from **the Global Hydrometry Support Facility (HydroHub)** infrastructure and mechanisms to help develop non-expensive water quality monitoring programmes in Members states where these are not in place yet.

Assumptions and risks

Proposed activities and outputs 8.3, 8.2 and 8.4 are based on basic assumption that relevant partners (UNEP, UNESCO, WB) will joint WMO in these activities following same goals and providing adequate resources necessary. Additionally, there's assumption of increasing demand from Member on water quality related actions from WMO. In particular, that Members, with no systematic programmes for water quality monitoring and assessment, will aim to develop and maintain water quality monitoring as a priority and contribution to SDG (outputs to 8.1, 8.5 and 8.2).

Global pandemic of COVID-19 represents an eminent risks for achievement of all outputs. Post-pandemic economic situation might further limit development of relatively expensive measures in water quality due to decrease of resources available and potential shift in priorities at national and global level for recovery from the pandemic. Limited resources might limit both, a demand from Members, as well as capacities of UN system to react. Additional risk for 8.1, 8.5, 8.2 and 8.4 would be a lack of expertise mobilized for WMO from Members expert database to deliver on planned activities. Given the fact that water quality is not a common responsibility of NHSs, experts often stay outside the NMHSs and might be difficult to be approached and attracted to contribute.

3) Partnership

Successful achievement of the Long-Term Ambitions and implementation of enhanced services will require partnerships to:

a) Foster collaboration for sustainable, improved, tailored and affordable hydrological services;

b) Strengthen the capacities of National Hydrological and Hydrometeorological Services;

c) Support regional and transboundary initiatives and approaches that optimize basin-wide water management, including hydrological data exchange;

d) Improve the general understanding of the societal benefits of hydrological services; and

e) Assist in responding to the requirements of international processes

4) Way forward?

Monitoring and assessment of the Action plan implementation

Monitoring and assessment of the Action plan implementation will be done by the Hydrological Coordination Panel based on inputs and monitoring of progress of work plan of Technical Commissions, Research Board, Regional Associations and other implementing bodies and by assessment of defined milestones and success criteria for all activities, outputs and outcomes. Report on progress will be produced biannually for consideration of EC and Congress/Hydrological Assembly respectively.

Review of the Action plan

Based on the monitoring and assessment, Hydrological Coordination Panel will develop in coordination with SERCOM, INFCOM, Research Board and Regional Associations an update of the Action plan and submit to Hydrological Assembly for endorsement and to adoption by regular Congress-19 (2023) and Congress-20 (2027).