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JOINT MEETING OF
CBS EXPERT TEAM ON SURFACE-BASED REMOTELY-SENSED OBSERVATIONS
(Second Session)
AND
CIMO EXPERT TEAM ON OPERATIONAL REMOTE SENSING
(First Session)

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REMOTE SENSING SYSTEMS ROLE IN THE EVOLUTION OF THE GOS AND THEIR INTEGRATION INTO WIGOS

Presentation of WIGOS Concept of Operations and Implementation Plan

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)
(Background Information)

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SUMMARY AND PURPOSE OF DOCUMENT

The document presents a brief summary of the WIGOS Concept, the guidance and recommendations of Cg-XVI (Geneva, May-June 2011), EC-LXIII (Geneva, June 2010) and ICG-WIGOS-1 (Geneva, 26-30 September 2011) related to the WIGOS implementation.

ACTION PROPOSED

The session is invited to note the relevant guidance and recommendations adopted by Cg-XVI, EC-LXIII, and ICG-WIGOS-1 to be followed to be followed by WMO constituent bodies for the planning, implementing and further development of WIGOS and its core observing components, including interoperability of observing systems, their long-term sustainability, standardization of instruments and methods of observation, and the quality management framework.

References:

1. Abridged Final report of the Sixteenth Congress (Geneva, May-June 2011);
2. Abridged Final report of the Sixty-third session of the Executive Council (Geneva, June 2011);
3. Abridged Final report of the CIMO-XV (Helsinki, 2010);
4. Abridged Final report of the CBS - Extraordinary session (Windhoek, 2010);
5. Draft Final Report of the first session of ICG-WIGOS (September 2011) *(under an approval)*

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)
(Background Information)

WIGOS CONCEPT

1. Vision

1.1. The WIGOS Concept of Operations (CONOPS) specifies the vision, benefits and other WIGOS basic characteristics and principles; the WIGOS Development and Implementation Strategy (WDIS) defines steps that WMO, in cooperation with partner organizations, will follow. These documents[1] provide guidance on how to improve governance, management, and integration of WMO observing systems and their contributions to co-sponsored systems, in order to satisfy evolving observing requirements of WMO Members and partner organizations in a coordinated, cost-effective and sustained manner.

1.2. The WIGOS vision calls for an integrated, coordinated and comprehensive observing system to satisfy, in a cost-effective and sustained manner, the evolving observing requirements of Members in delivering their weather, climate, water and related environmental services. However, WIGOS is not a new observing system.

1.3. WIGOS will provide a framework and mechanisms for enabling the integration and optimized evolution of WMO observing systems, and of WMO's contribution to co-sponsored systems. Together with the WMO Information System (WIS), this will allow continuous and reliable access to an expanded set of environmental data and products, and associated metadata, resulting in increased knowledge and enhanced services across all WMO Programmes.

1.4. The WIGOS vision provides a roadmap to guide the orderly evolution of the WMO observing systems operated by Members into an integrated system. Establishing the effective and sustained organizational, programmatic, governance and procedural structures is needed for a common standardization process facilitating interoperability of WIGOS observing components, data compatibility, and for implementation of quality management procedures. It will enable those user requirements for various application areas to be met at national, regional and global levels.

2. Benefits

2.1. WIGOS will significantly enhance observing capabilities of Members by maximizing their administrative and operational efficiencies, through a more coordinated, collaborative and cost-effective approach to the planning and operation of an integrated global observing system.

2.2. The functions performed by WIGOS are crucial to the future of WMO. Implementation of WIGOS will enable Members, in collaboration with national agencies, to meet countries' observational requirements for improving timely advisories and early warnings on extreme weather and climate events. It will also enable them to improve weather, climate, water and related environmental monitoring and forecast services, and to adapt to and mitigate climate change, especially in developing and least developed countries. It will improve Members' abilities to meet expanding national mandates

[1] http://www.wmo.int/pages/prog/www/wigos/WIGOS_Cg-XVI.html

and promote higher visibility for National Meteorological and Hydrological Services (NMHSs) with other agencies focused on environmental issues.

2.3. WIGOS is essential for realizing the socio-economic benefits from a wide range of products and services linked to the core WMO competencies of weather, climate, water and related natural disasters. The implementation of WIGOS is an imperative if the Organization is to make the best use of advances in observing technology and new types of data addressed in the GAW and WHYCOS strategic plans and in the Vision for the GOS in 2025.

2.4. WIGOS is also essential to meeting the emerging demand for WMO activities, such as integration of observations from the Global Cryosphere Watch and satisfying the observational needs of the Global Framework for Climate Services, disaster risk reduction, and aeronautical meteorology. It will also ensure a coordinated WMO contribution to the co-sponsored systems (GCOS, GOOS, GTOS), and to the Global Earth Observation System of Systems (GEOSS).

2.5. By providing more timely and accurate information, NMHSs help decision-makers protect populations and prevent natural hazards from becoming disasters. Investments in weather, climate and water information and services produce an economic return many times greater than the original amount invested, and represent an investment in well-being and prosperity for all.

2.6. WIGOS, together with WIS, will be the basis for the provision of accurate, reliable and timely weather, climate, water and related environmental observations and products by all Members and WMO Programmes, which will lead to improved service delivery.

2.7. The delivery of high-quality climate services requires a coordinated, comprehensive observing component that can be supplied only by WMO Members and the Organization's national and international partners. One goal of WIGOS is to meet this need by providing compatible, quality-assured, quality-controlled and well-documented long-term observations as well as for other enhanced and extended services provided by Members.

3. WIGOS and service delivery

3.1 The WIGOS key functions can be characterized in a following way:

- To facilitate standardization and interoperability[2] and, together with WIS, ensuring availability and utilization of, and access to, good-quality data and products, and associated metadata;
- To provide the mechanism for interaction and cooperation with the WMO co-sponsored observing systems, respecting partnership, ownership and data-sharing policies of all observing components and partner organizations. WMO works with partner organizations to achieve maximum commonality of standards and practices across the co-sponsored observing systems;
- To provide the partnership between WMO and international partner organizations with a shared responsibility for the design, operation, and coordinated and optimized evolution of observing systems under their responsibility, respecting the ownership.

[2)] Interoperability is a property referring to the ability of diverse systems to work together (inter-operate)

3.2 WIGOS is driven by service delivery requirements for the benefit of society, sustainable development and environmental protection (see Fig. 1). The success of WIGOS depends on its ability to interact with its user community to meet their needs and requirements. In this regard, the GAP analysis and the RRR process are used extensively.

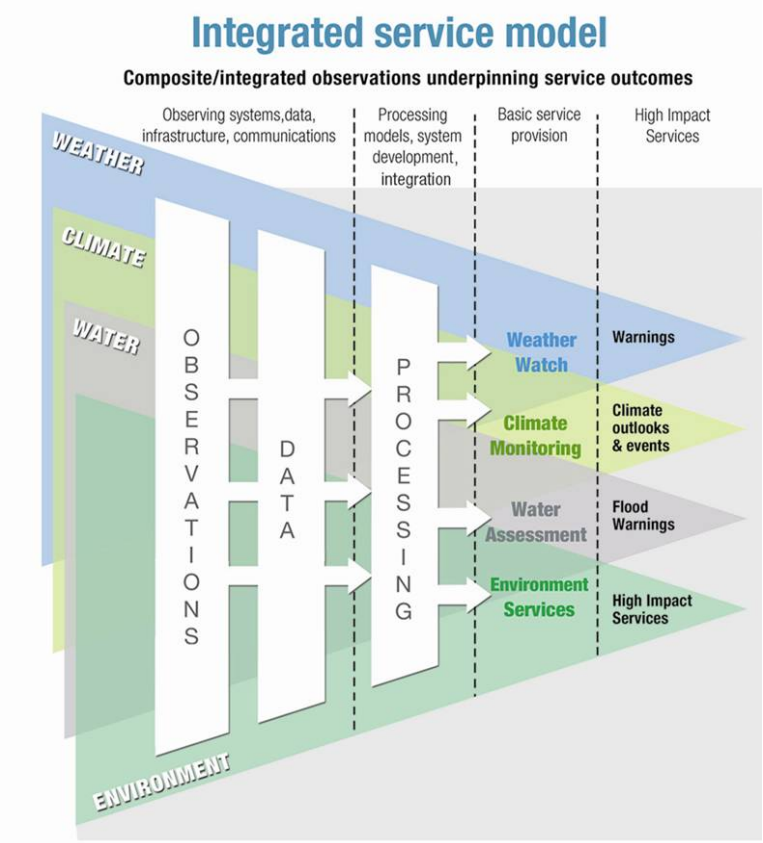

Fig 1: Integrated Service Model supported by WIGOS

3.3 GFCS requires a coordinated, comprehensive observing component that can be supplied only by WMO Members and the Organization's national and international partners. Functions performed by WIGOS are essential for satisfying the observational needs of GFCS (sustained, uninterrupted, compatible, quality-assured, quality-controlled and well-documented long-term observations, based on standard procedures and best practices), fully supporting observational requirements of health, food, water, and many other sectors.

3.4 Observing systems currently being used mainly for weather services (early warning, nowcasting and forecasting) will have to be strengthened and upgraded to meet needs and requirements of climate services as well.

4. WIGOS "building blocks"

Planning and optimized evolution of WIGOS observing components:

4.1 WIGOS will provide a mechanism to meet evolving observing requirements of WMO Members

and partner organizations. Coordinated planning based on the gap analysis and the updated RRR process with new application areas important from a climate perspective, has a great potential to enhance observing system capabilities and to increase cost-effectiveness of observing efforts and investments. This mechanism will address gaps and shortcomings of existing observing systems.

4.2 This activity will be performed through the following:

- A systematic rolling review and validation of observing requirements from each of the user communities WIGOS intends to serve, and maintain a consolidated and evolving set of requirements;
- A regular review of the observing capabilities that are actually implemented, and a continuous monitoring of their performances;
- A review of emerging service delivery and research requirements and the potential of new technology to enhance or complement current observing capabilities to meet their needs.

4.3 This process, conducted with close involvement of both the operational and research communities, should result in the Statements of Guidance for all application areas in which observations are used to support WMO programmes. Key gaps in observing capabilities identified by the Statements of Guidance will result in proposals for activities to fill these gaps.

4.4 An observing network design will be addressed through a coordinated effort of NMHSs and other data providers by minimizing duplication and optimizing the observing network design and its flexibility to incorporate new observing systems after their successful testing and evaluation.

4.5 It can be a mix of systems with the optimized geospatial/temporal distribution of observing points and data to meet global/regional/subregional/national needs in accordance with requirements of significant users and applications areas. Where there are a large number of smaller countries and/or large areas of ocean, this may be a practical move forward.

4.6 In this regard, long-term testing at instrument “test-beds” will be used to judge instrument design, performance, reliability, capability, and cost-effectiveness for a full integration into WIGOS; to develop standard procedures and guidance related to instrument use and operation.

4.7 ***Implementation milestones:*** By 2015, the Vision for WIGOS and its implementation plan, including technical guidance on how to design, develop and implement an integrated national observing system be developed and available; Architecture for Climate Monitoring from Space be developed.

Standardization, including metadata

4.8 WIGOS will utilize international standards and best practices set by WMO and partner organizations to reflect accordingly the ongoing rapid progress in technology that will continue to provide a basis for further improvements in the reliability, traceability, consistency, quality and cost-effectiveness of observations.

4.9 Standardization will address standard and best procedures and practices in three key areas, as indicated in the Fig. 2 including quality assurance, quality control and data management for existing, emerging and new technologies. Standardization is needed for all observational data and products, and associated metadata so that observations from individual systems are consistent and comparable, and can be integrated into accurate and coherent data sets that allow for the development of unbiased, homogeneous long-term time-series with known and documented quality. Observing system interoperability achieved by standardization process is key to turning observations into effective data that meet re al needs.

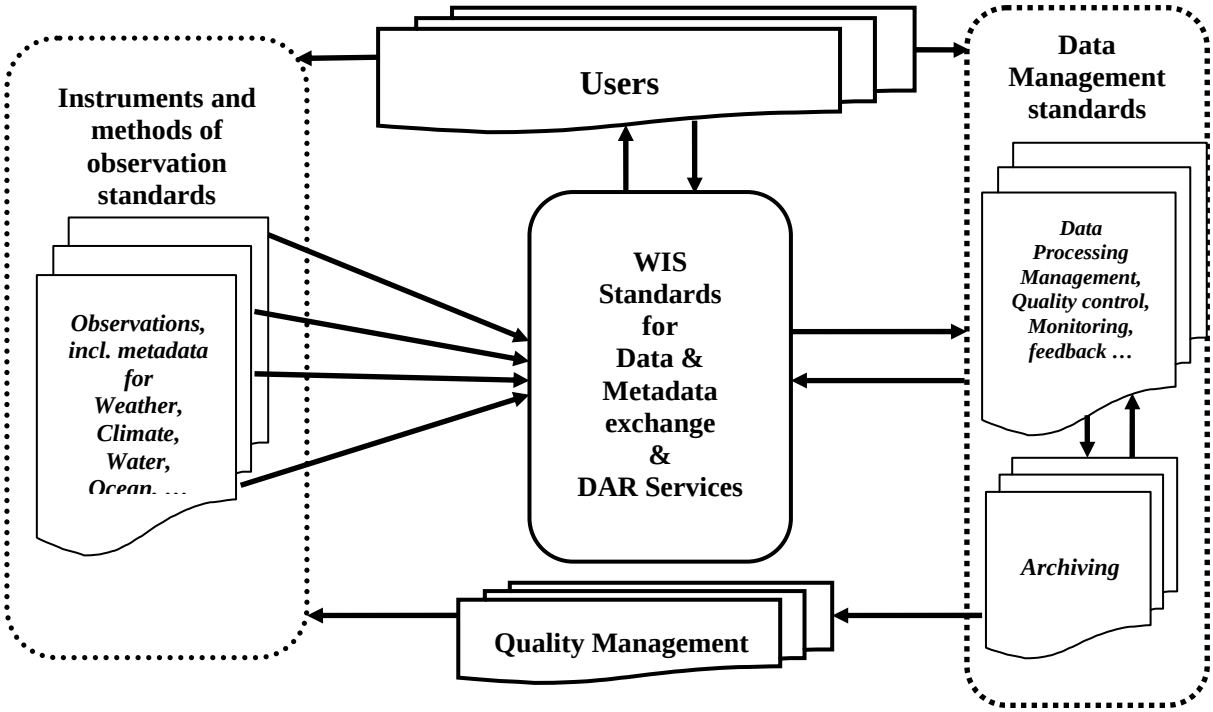

Fig. 2: WIGOS key areas of standardization (observations, WIS, QMF)

4.10 The WIGOS standardization process will have to adequately address the differences and inconsistencies in current technical specifications, data acquisition and management systems used by individual NMHSs and partner organizations before national and international observing systems can be regarded as truly integrated.

4.11. A common standardization process and uniform implementation of WMO regulations and practices will ensure compatibility and integration of WIGOS observational data/products and will facilitate interoperability across all WMO observing systems.

4.12 The concept of WIGOS is based on the premise that the general standards and recommended practices, as agreed-upon for WIGOS, will apply to all WMO and, to the extent possible, co-sponsored observing systems. Strong collaboration, cooperation and coordination are needed among all partners to achieve maximum commonality of standards and practices across the co-sponsored observing systems.

4.13 ***Implementation milestones:*** By 2015, the strategy for the standardization process *(or the standardization process as itself)* finalized; WMO Technical Regulations updated; Manual and Guide on WIGOS developed; all approved by Cg-XVII.

4.14 Regarding the WIGOS metadata implementation process, the following three phases can be identified: (1) development of standards/best practices; (2) their implementation; and (3) reporting / updating WIGOS metadata. The first step should be an inventory of what has been already done in this area, including legacy and emerging metadata recording/documenting methods, by CBS and its OPAG/IOS and OPAG/ISS, and other relevant technical commissions. It will help to understand a scope of this issue, especially legacy and emerging metadata recording/documenting methods.

4.15 Creating the WIGOS Core Metadata that is needed by the majority of users is urgent and high priority; that Core might expand in time, and individual centres and Programmes may extend the WIGOS metadata they exchange beyond the Core, but users should expect that the Core contents will be available for WIGOS observations, and that the contents of the Core will be stable over time. WIGOS Core metadata will provide sufficient information for the majority of users to make

appropriate use of the observations and to allow the observations to be used in an appropriate and defensible way for high-impact studies or legal processes.

4.16 ***Implementation milestones:*** By 2015, the WIGOS Core Metadata Standard developed; technical guidance available; the initial core standard implemented.

Quality Management, including monitoring, evaluation, feedbacks, corrective measures

4.17 Meeting the quality requirements and expectations of users is critical to the success of WIGOS. This will require an in-depth examination of current practices used by WMO observing programmes, specific mission-related requirements that are already in place, and available technological opportunities. It will also be important to review the quality not only of the deliverables produced by WIGOS but also of the management processes involved.

4.18 The standard Quality Management System (QMS) that specifies all quality assurance (QA) and quality control (QC) standards/best practices for the national observing system developed by CBS in collaboration with other technical commissions and implemented at a national level by Members ensures reliability, quality and timeliness of data streams with adequate quality control and relevant metadata.

4.19 The implemented QMS ensures that observational data and products are compliant with relevant joint standards agreed upon with other international organizations and consistent with the WMO QMF and its Quality Policy. In this regard, the key issues are: to document all processes and procedures used; to document quality of observation at any stage of data processing; and to strive where possible to guarantee traceability to international standards.

4.20 A systematic and rigorous performance monitoring and evaluation (PM&E) of WIGOS capabilities in terms of both the flow of observational data/products to models and provision of products/information for decision-support tools and services in accordance with requirements specified by end users improve the overall performance of WIGOS and its ability to interact with its user community and to meet community needs and requirements.

4.21 The Manual and Guide on WIGOS specify QMS standard practices and procedures (in the Manual) and those only recommended (in the Guide), including the guidance how to monitor and manage the observing system to fully meet WMO QMF requirements.

4.22 ***Implementation milestones:*** By 2015, QMS procedures developed and incorporated in to the Manual and Guide on WIGOS accordingly.

Data delivery and services of WIS, including data/metadata management

4.23 WIGOS is crucially dependant upon effective WIS support and services. WIS is the core interoperability layer of WIGOS. It allows otherwise independent observing systems to move data between them, as well as provide the standards and best practices for standardized and more effective data management and archiving. WIS also supports the collection and sharing of observations and products within WIGOS and allows new initiatives such as the enhanced climate services being developed under the framework of GFCS to benefit easily from WIGOS data and products.

4.24 With regard to the organization of an efficient and effective data collecting and processing, as well as to guarantee rapid and flexible data/metadata access for all key applications, the idea of a central platform with an integrated and consistent data pool becomes pivotal. This approach should be put in a practice by setting up and operating a Data Warehouse (DW) system for data/metadata processing, management and information purposes. WIS Centres (National Centres / Data Collection or Production Centres) should be used for these purposes.

4.25 ***Implementation milestones:*** By 2015, WIS data management standards, principles and practices are applied through all WIGOS data management activities, incl. metadata.

WIGOS support tools

4.26 A distributed operational database (DB) describes all WIGOS observing components providing the end users with relevant metadata crucial for the operation of WIGOS and for the WIS Data Discovery, Access and Retrieval (DAR) services. DB also supports user activities on the network evaluation, redesign and optimization, system governance, management and all other aspects dealing with observing system operation and performance. DB provides access to information on all QMS processes, including performance monitoring implemented by the owners of WIGOS observing components. Data Producers are responsible for providing detailed and correct metadata related to all parts of their observing systems and networks.

4.27 WIGOS Standardization database provides a user-friendly direct access to, and on-line search tool for all WMO standards, guidelines, best practices, etc., addressing all aspects of observations (instruments, methods of observation, metadata format, coding, etc.). This DB enables the network managers and operators to easily access the information they need to set-up and run their systems and to help the data users to understand the standards used in generating specific observations needed for their applications. It will help Members and Partners to improve and standardize their observing networks according to WIGOS requirements.

4.28 The WIGOS portal provides access to all WIGOS related information and services and to the WIGOS Operational, Standardization and the WMO Observing Requirements Database (the original CEOS-WMO Database on Observing Capabilities).

4.29 ***Implementation milestones:*** By 2015, WIGOS Databases and Portal established.

WMO regional centres

4.30 WMO Regional Centres (such as WIS DCPCs, RICs, RMICs, RCCs, RTCs, etc.) play a key role in several different areas, such as:

- providing adequate support to all WIGOS processes;
- helping to identify and address regional needs and priorities;
- supporting continuous update and optimization of the regional observing network through the implementation of the RRR process;
- supporting compliance of national observing system procedures with the WMO Technical Regulations, including traceability to international standards;
- supporting WIGOS databases;
- supporting data management and quality management related activities and tasks, such as quality control, monitoring, feedbacks, remedial actions, etc.;
- monitoring of the regional WIGOS implementation;
- supporting regional/subregional collaboration and cooperation for enhanced observing capabilities of the Region;
- sharing knowledge, experiences.

4.31 Their capabilities to serve their original purpose are enhanced and strengthen to be the components of an effective WMO virtual network for the operational WIGOS and, of course, for GFCS.

4.32 A set of targeted GFCS/WIGOS projects to enhance and strengthen capabilities of different

WMO Regional Centres (for WIS; instruments calibration; processing and forecasting; climate; education and training) should be designed and implemented as a fast track solution. All these Centres could and should be the components of an effective WMO virtual network for the operational WIGOS and, of course, for GFCS.

4.33 ***Implementation milestones:*** By 2015, at least some WIS centres, RICs and RMICs are strengthened to meet WIGOS QMS requirements.

WIGOS IMPLEMENTATION

(Summary of guidance and recommendations by CIMO-XV, CBS-Ext(2010), Cg-XVI, EC-LXIII, and ICG-WIGOS-1)

5. Decisions by CIMO-XV

5.1 Taking into account WIGOS requirements, CIMO-XV agreed on the following priority areas:

(a) Development of relevant WIGOS standards in collaboration with partners; including WIGOS metadata standards;

(b) Provision of the technical guidance and advice to Members and regional associations on instruments and methods of observation for use within WIGOS;

(c) Update, harmonization and development of WMO Regulatory Material, including the development of a new WIGOS Manual and/or Guide.

6. Decisions by CBS-Ext(2010)

6.1 Taking into account key tasks specified by WDIS, CBS-Ext(2010) agreed on the following priority areas during the next intersessional period:

(a) Development of the EGOS-IP including the updating of the application areas of the RRR process;

(b) Development of WIGOS standards, including QM procedures and metadata standards, in close collaboration with other technical commissions and partner organizations;

(c) Provision of the technical guidance and advice to Members and regional associations on WIGOS;

(d) Review, update and harmonization of WMO regulatory material that must document the structure and requirements of WIGOS operations.

7. Decisions by Cg-XVI, EC-LXIII; guidance and recommendations

7.1 Congress reiterated that the current WMO observing systems had been developed and administered separately in the past to meet diverse sets of requirements. Congress stressed that such multiplicity of observing systems operated for different WMO Programmes had, however, resulted in incompatibilities and deficiencies, duplication of effort and higher overall costs for Members.

7.2 In sharp contrast to this, Congress noted an increasing demand to provide a wide range of high-quality data, products and services to satisfy the multifaceted requirements of end-users for the benefit of society, sustainable development and environmental protection. Congress recognized that enhanced

synergies, including systems interoperability and compatibility, would help meet evolving requirements of Members and their national and international partners. Further progress, will depend on adopting a new, integrated approach to upgrading the WMO observing system that is WIGOS.

7.3 Congress decided that the WIGOS implementation be undertaken in an active and prudent manner in the sixteenth financial period and will focus on developing and implementing a framework for improved governance, management, integration and optimization of the multiple observing systems coordinated by WMO, and it will lay the groundwork for an operational system from 2016 onward.

7.4 Congress emphasized that the implementation of WIGOS should build upon and add value to the existing WMO observing systems with emphasis on integration of surface- and space-based observations in an evolutionary process to satisfy requirements of WMO and WMO co-sponsored Programmes. Congress noted that, since all WMO Programmes would benefit, each should actively participate and contribute its own expertise and resources in implementing WIGOS.

7.5 Congress recognized the important role of WIS in WIGOS implementation, in relation to data exchange and discovery, and the provision of effective standards and practices for data management. Congress stressed the importance of coordination between WIGOS and WIS implementation activities.

7.6 Congress also recognized that meeting the quality requirements and expectations of users will be critical to the success of WIGOS. This would require an in-depth examination of current practices used by WMO observing programmes, specific mission-related requirements that were already in place, and available technological opportunities. The WIGOS implementation strategy would specify all processes of the Quality Management System (QMS) for WIGOS observing components including guidance on effective management of such a component.

7.7 Taking into account the ongoing rapid progress in technology that will continue to provide a basis for further improvements in the capability, reliability, quality and cost-effectiveness of observations, WIGOS must utilize international standards and best practices set by WMO and partner organizations.

7.8 Congress requested the Council to provide oversight on the implementation of WIGOS as one of the priorities of the Organization. Recognizing the significance of active cooperation and enhanced coordination among technical commissions (TCs), regional associations (RAs) and WMO partners, Congress noted that it would be desirable for an Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) to be established during the implementation process with representatives of RAs and partner organizations.

7.9 To avoid any duplication and to ensure consistency and effectiveness, requirements of GFCS and other WMO priorities needed to be reflected in the relevant implementation plans for global, regional/sub-regional and national levels to be developed by the WMO Secretariat, RAs and NMHSs, respectively.

7.10 Congress agreed that the implementation of WIGOS must be reflected in the revised WMO Technical Regulations, documenting the WIGOS concept of operations and contributions of all observing components. In this regard, the Congress endorsed the inclusion of the Manual on WIGOS in the list of mandatory publications.

7.11 Congress emphasized the importance of the development of the WIGOS operational and standardization databases specified in CONOPS as critical WIGOS framework support tools and establishment and management of a WIGOS portal that would provide relevant information to stakeholders on WIGOS and to ensure free access to its databases, noting relevant resolutions on data exchange and any future developments in this area.

7.12 Congress agreed that centralized coordination through the WMO Secretariat was important for the successful WIGOS implementation. It agreed that establishment of the WIGOS Project Office with appropriate project management functions, sufficient staffing and funding will be essential to support the WIGOS implementation. The WIGOS Project Office will, inter-alia, coordinate with Members, the TCs and the RAs.

7.13 Congress adopted Resolution 11.3/1 (Cg-XVI) - Implementation of the WMO Integrated Global Observing System (WIGOS) (Appendix II to this document), by which all technical commissions were requested to:

- Guide the technical aspects of WIGOS implementation;
- Incorporate WIGOS implementation activities in their operating plan and work programme;
- Provide technical guidance and advice to Members and the regional associations on WIGOS;
- Develop guidance for the design and evolution of observing components of WIGOS,
- Develop standards to support WIGOS in collaboration with partner organizations and programmes;
- Update WMO Regulatory Material, including development of the Manual on WIGOS;
- Provide the technical lead for WIGOS through the ***Commission for Basic Systems (CBS) and the Commission for Instruments and Methods of Observation (CIMO)***;

7.14 The Council adopting Resolution 2/2 (EC-LXIII) established an Inter-Commission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS), specifically to coordinate and prioritize WIGOS-related activities carried out by relevant technical commissions for all WMO domain areas, including deserts and drylands; and to provide technical guidance and assistance for the planning, implementation and further development of the Global Observing System, the Global Atmosphere Watch, the World Hydrological Cycle Observing System and the Global Cryosphere Watch (GCW) as core components of WIGOS, including interoperability of observing systems, their long-term sustainability, standardization of instruments and methods of observation, and the quality management framework.

8. *Relevant recommendations and guidance by ICG-WIGOS-1*

8.1 Close collaboration with, and contribution from regional stakeholders, partner organizations, co-sponsoring agencies, regional/subregional intergovernmental, economical groupings and funding organizations are needed; therefore, they should be engaged in the implementation activities from the very beginning.

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