WORLD METEOROLOGICAL ORGANIZATION

EXECUTIVE COUNCIL WORKING GROUP ON WMO INTEGRATED GLOBAL OBSERVING SYSTEM AND WMO INFORMATION SYSTEM

Third Session

Geneva, Switzerland, 24-26 March 2010

FINAL REPORT

DISCLAIMER

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box No. 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0)22 730 84 03
Fax: +41 (0)22 730 80 40
E-mail: Publications@wmo.int

CONTENTS **PAGES**

AGENDA p. 4
Executive Summary p. 5
General Summary p. 6
List of Participants (Appendix I) p. 16
WIGOS Concept of Operations (CONOPS) (Appendix II) p. 20
WIGOS Imperative (Appendix III) p. 45
WIGOS Development and Implementation Plan (WDIP) (Appendix IV) p. 54
WIGOS Development and Implementation Strategy (WDIS) (Appendix V) p. 63
Draft resolution 3.4/3 (EC-LXII) – Implementation of WIGOS (Appendix VI) p. 82
Future Work Programme and Action Plan of EC WG (Appendix VII) p. 85
Annex to paragraph 10.1 p. 86

_____

AGENDA

1. ORGANIZATION OF THE SESSION
2. REVIEW OF GUIDANCE AND RECOMMENDATIONS ADOPTED BY EC-LXI
3. WIS PROJECT AND IMPLEMENTATION PLAN
4. REPORT OF SUB-GROUP ON WIGOS
5. WIGOS PROJECTS
6. WIGOS CONCEPT OF OPERATIONS (CONOPS)
7. WIGOS INTRODUCTORY PUBLICATION
8. WIGOS DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP)
9. WIGOS DEVELOPMENT AND IMPLEMENTATION STRATEGY (WDIS)
10. REPORT ON THE INTEGRATION BETWEEN THE WMO OBSERVING SYSTEMS
11. RECOMMENDATION FOR EC-LXII
12. FUTURE WORK PROGRAMME AND ACTION PLAN OF EC WG
13. ANY OTHER BUSINESS
14. CLOSURE OF THE SESSION

_____

EXECUTIVE SUMMARY

The third session of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS) was held at the WMO Secretariat in Geneva, Switzerland, from 24 to 26 March 2010. The session was chaired by Prof A. Divino Moura (Brazil), Third Vice-President of the WMO and Chair of EC WG.

EC-WG/WIGOS-WIS reviewed major deliberations of the second session of its Subgroup on WIGOS (SG-WIGOS-2, Geneva, Switzerland, 19-23 October 2009), and the sixth session of the Inter-Commission Group on WIS (ICG-WIS, Seoul, Republic of Korea, 22-26 February 2010) and developed appropriate proposals and recommendations. EC-WG/WIGOS-WIS further considered:

(a) Report on the WIGOS Projects (Status, Evaluation, Lessons Learned);
(b) WIGOS Concept of Operations (CONOPS);
(c) WIGOS Test of Concept Development and Implementation Plan (WDIP);
(d) WIGOS Development and Implementation Strategy (WDIS);
(e) Report on the integration between the WMO observing systems.

Based on the outcomes of the discussion under individual Agenda Items, EC-WG/WIGOS-WIS formulated recommendations on the further development and implementation of the WIGOS concept, the implementation of WIS, and the enhanced coordination of WIS and WIGOS activities. EC WG decided to submit the updated versions of CONOPS (Appendix II), WDIP (Appendix IV) and WDIS (Appendix V) to EC-LXII for consideration and endorsement.

Particular attention was given to the WIGOS Projects being initiated during the WIGOS Test of Concept phase. EC-WG/WIGOS-WIS noted that in spite of the limited time frame and resources, the WIGOS Projects provided a valuable learning experience to validate proposed approaches to integration, identify problematic areas, help to understand WIGOS benefits and identify more effective ways to move forward. Lessons learned constituted a valuable input for WIGOS planning and development, for the development and updating of CONOPS, WDIS and other WIGOS documentation, and for additional WIGOS projects and activities.

EC-WG/WIGOS-WIS formulated recommendations on further WIGOS development to be submitted to EC-LXII for consideration and approval. EC WG adopted its Future Work Programme and Action Plan (Appendix VII).

GENERAL SUMMARY

1. ORGANIZATION OF THE SESSION

1.1 Opening of the meeting

1.1.1 The third session of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS) was opened by its Chair, Prof A. D. Moura, Third Vice-President of WMO, at 10:00 hours on Wednesday, 24 March 2010, at the WMO Headquarters in Geneva, Switzerland.

1.1.2 On behalf of the Secretary-General, Dr W. Zhang, Director of the Observing Systems and Information Department, welcomed the participants to Geneva. He underlined the role and the importance of the WG and highlighted the most important topics to be addressed by this session, including the status of Implementation of the WIS Project and Implementation Plan, the status of the WIGOS Pilot and Demonstration Projects and lessons learned, the updated version of CONOPS, and the status of progress with the WIGOS Test of Concept Development and Implementation Plan (WDIP). He emphasized the importance of the draft WIGOS Development and Implementation Strategy for taking WIGOS from concept to reality. Dr W. Zhang underlined that the deliberations of this session would be of particular importance in the preparation of a comprehensive document on WIGOS implementation to be submitted to Cg-XVI.

1.1.3 The list of participants is given in Appendix I.

1.2 Adoption of the agenda

EC-WG/WIGOS-WIS adopted the Agenda for the meeting, which is reproduced at the beginning of this report.

1.3 Working arrangements

EC-WG/WIGOS-WIS agreed on its working hours and adopted a tentative work plan for consideration of the various agenda items.

2. REVIEW OF GUIDANCE AND RECOMMENDATIONS ADOPTED BY EC-LXI

2.1 EC-WG/WIGOS-WIS reviewed the guidance and recommendations by EC-LXI on the further development and implementation of WIGOS. During the discussion, it noted the need to further clarify the role of WIGOS in the context of strengthening the collaboration with WMO partners and ensuring its vital support to the WMO co-sponsored Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS). EC-WG/WIGOS-WIS felt that actions for the improvement of the above collaboration mechanisms should start prior to Cg-XVI. It was also underlined that the Executive Council requested, inter-alia, to clarify costs involved in the WIGOS implementation and address the issues to secure the sense of ownership. EC-WG/WIGOS-WIS agreed that the visibility of all agencies at national and international levels as a part of an interdisciplinary and interagency framework should be clearly shown in the WIGOS documentation.

2.2 EC-WG/WIGOS-WIS agreed that WMO has the opportunity to enhance its profile and political credibility by pointing out how effectively it contributes, through WIGOS, to the global observing systems for climate in support of UNFCCC.

2.3 In view of the concern expressed at EC-XLI that neither WIGOS nor its relation to the established global observing systems was yet well understood, EC-WG/WIGOS-WIS stressed the need for the various WIGOS planning documents to more clearly reflect the contribution which a successfully implemented WIGOS would make to the effectiveness of GOOS, GTOS and GCOS, which WMO co-sponsors with other agencies. EC-WG/WIGOS-WIS noted, in particular, that EC-XLI

had recalled that WMO's climate observing activities are carried out as part of the cross-domain GCOS which WMO co-sponsors with IOC, UNEP and ICSU. EC-XLI had stressed the need to ensure that the climate components of WIGOS are effectively integrated with those of GOOS, GTOS and other climate-relevant global observing systems through close alignment of GCOS and WIGOS planning.

2.4 EC-WG/WIGOS-WIS was advised of the widespread support at SBSTA-31 in Copenhagen in December 2009, for the provisional update of the "Implementation Plan for the Global Observing System for Climate in support of the UNFCCC" (which includes a large number of WIGOS-related implementation actions) and for the strengthening of GCOS as the essential observational element of the proposed new Global Framework for Climate Services (GFCS). EC-WG/WIGOS-WIS concluded therefore, that, while the WIGOS concept is a framework for improved integration of all its observing activities, it would reflect well on WMO to strongly emphasize the WIGOS contribution to GCOS and hence to meeting the observational needs of both the UNFCCC and the future GFCS.

3. WIS PROJECT AND IMPLEMENTATION PLAN

3.1 EC-WG/WIGOS-WIS was briefed by Prof G.-R. Hoffmann, Chair of the Inter-Commission Coordination Group on WIS (ICG-WIS) and the WIS Project Manager on the status of implementation of the WIS Project, including the designation process of WIS centres.

3.2 While appreciating efforts on the implementation of the WIS Project and Implementation Plan, the EC-WG/WIGOS-WIS noted that there is still a need to improve understanding and confidence level of WIS (and also WIGOS) by WMO Members and partner organizations. It agreed that arrangements for WIS and WIGOS demonstrations would be critical to address this issue.

3.3 EC-WG/WIGOS-WIS noted with satisfaction the WIS designation and demonstration processes; at least, three Global Information System Centres (GISC) and two Data Collection or Production Centres (DCPC) (NCAR and ECMWF) will be presented at EC-LXII. More centres will be established by, and presented during CBS-Ext.(2010) and Cg-XVI (2011).

3.4 EC-WG/WIGOS-WIS underlined that more WIS documentation was still needed and should be prepared as a matter of priority. In this regard, EC-WG/WIGOS-WIS agreed that the WIS Project Office should continue at least two years after Cg-XVI to meet these requirements.

3.5 EC-WG/WIGOS-WIS noted that WIS metadata was fairly easy obtained (from the GISC perspective) but there was already an urgent need to get metadata from WIGOS. EC-WG/WIGOS-WIS requested its SG-WIGOS to address this issue accordingly.

4. REPORT OF SUB-GROUP ON WIGOS

4.1 EC-WG/WIGOS-WIS noted with appreciation the Final Report of SG-WIGOS-2 (Geneva, 19 - 23 October 2009) that provided valuable proposals and recommendations on the further development of WIGOS.

4.2 EC-WG/WIGOS-WIS agreed that greater emphasis should be placed on the role of WIGOS in achieving internal coordination, across WMO programmes and constituent bodies, of the various WMO contributions to GCOS through GOS, GAW, WHYCOS and other climate-related observing activities.

4.3 In addition to providing a framework for better WMO user access to the observing systems sponsored or co-sponsored by WMO's partner organizations, WIGOS planning should place greater emphasis on achieving a coordinated WMO contribution to these systems, especially the IOC-lead GOOS and the FAO-lead GTOS.

4.4 EC-WG/WIGOS-WIS agreed that the development of databases will be essential for WIGOS

to move forward with integration of the WMO observing systems. This will include the development of distributed standard databases for WIGOS metadata and WMO standards to make them interoperable. EC-WG/WIGOS-WIS also agreed that more detailed description of proposed databases is needed and it should be incorporated in CONOPS as well as in WDIS.

4.5 EC-WG/WIGOS-WIS expressed its concern regarding missing descriptions of objectives of the WIGOS databases, their roles and specific outcomes. It agreed that more specific descriptions would be added to relevant documents.

4.6 EC-WG/WIGOS-WIS noted the importance of distinguishing between the WIGOS and the WIS databases as well as metadata and agreed that it should be reflected as appropriate in relevant documents.

4.7 EC-WG/WIGOS-WIS agreed on the urgent need to develop metadata vocabulary and standards for WIGOS observational data that will meet requirements of all WMO programmes and all data producers. It was underlined that the lack of such vocabulary and standards would not allow some projects to be accomplished as planned. EC-WG/WIGOS-WIS agreed that the CBS Inter-Programme Expert Team on Metadata and Data Interoperability (IPET-MDI) with representatives of relevant partner organizations should play a key role in this development.

4.8 EC-WG/WIGOS-WIS reiterated that there is the need for resources (expertise and funding) as well as for active coordination and cooperation to accomplish this task, which is critical for a successful WIGOS implementation.

5. WIGOS PROJECTS

5.1 EC-WG/WIGOS-WIS noted the progress in the WIGOS Projects. It appreciated the role and input of the relevant technical commissions and AMDAR Panel in initiating and implementing WIGOS Pilot Projects (WPP). EC-WG/WIGOS-WIS also expressed its appreciation for the efforts of Kenya, Morocco and Namibia (RA I), Republic of Korea (RA II), Brazil (RA III), the United States of America (RA IV), Australia (RA V) and the Russian Federation (RA VI) in implementation of their WIGOS Demonstration Projects (WDP). Detailed information on the individual Projects as provided by Project Focal Points is available on the WIGOS web page at: http://www.wmo.int/pages/prog/www/wigos/projects.html.

5.2 EC-WG/WIGOS-WIS acknowledged that some Pilot and Demonstration Projects had not yet been completed. Some projects were designed to be ongoing while some others were unable to be completed because of the need for additional guidance material and standards still to be developed. However, in all cases there were a significant number of lessons learned. In this regard, EC-WG/WIGOS-WIS underlined that these pilot and demonstration projects should continue to be an important activity in the later WIGOS implementation stages, especially in assisting LDCs and SIDS countries to more fully benefit from WIGOS.

5.3 EC-WG/WIGOS-WIS noted that, although the detailed reports on the various Pilot and Demonstration Projects had revealed a wide range of critical issues associated with lack of clarity of the WIGOS concept, lack of guidance and lack of time and resources, the projects had, in fact, proved to be extremely valuable in identifying many key issues that will have to be addressed to ensure full implementation of WIGOS.

5.4 EC-WG/WIGOS-WIS agreed that Projects provided lessons learned, feedbacks and perspectives on the potential benefits, value and impacts of the WIGOS implementation process at the national, regional and technical levels which were necessary for the finalization of CONOPS and WDIS. EC-WG/WIGOS-WIS reaffirmed that the success of the WIGOS process will strongly depend on the collaboration and cooperation among WMO Members as well as among WMO and its partner organizations.

5.5 In this regard, EC-WG/WIGOS-WIS agreed that WIGOS implementation activities be

incorporated into operating plans and work programmes of the regional associations and technical commissions. Further, it requested the Council to encourage regional associations to develop their regional WIGOS implementation plans and coordinate WIGOS implementation activities, as well as to establish WIGOS-related Task Teams and to initiate regionally focused WIGOS-WIS activities.

5.6 EC-WG/WIGOS-WIS noted that implementation of projects required active coordination, guidance and support from the WIGOS Planning Office. It agreed that for this purpose a suitable project management function needed to be established. This will also ensure better interaction between the WIGOS Project Teams, SG-WIGOS and the respective technical commission working bodies. Also, technical guidance specifically on metadata issues is urgently needed (see also 4.5).

5.7 EC-WG/WIGOS-WIS agreed that the Secretariat via its future WIGOS Project Office should support regional associations in developing their WIGOS implementation strategies and projects, including outreach and capacity-building activities.

5.8 EC-WG/WIGOS-WIS also agreed that the revised structure of WMO technical regulations must clearly and unambiguously document the structure and requirements of WIGOS operations, adequately reflecting contributions of all component systems. Upon the approval by Cg-XVI, WIGOS Implementation Plan should include the development of the Manual on WIGOS as a priority activity.

6. WIGOS CONCEPT OF OPERATIONS (CONOPS)

6.1 EC-WG/WIGOS-WIS welcomed the updated version of the WIGOS Concept of Operations (CONOPS, version 4.1.1) elaborated by the Secretariat in accordance with the recommendations of EC-WG/WIGOS-WIS-2 (May, 2009) and SG-WIGOS-2 (October 2009) that had been reviewed and updated by the CBS-CIMO WIGOS coordination meeting, 22-23 March; it appreciated the good progress achieved in the further development of the WIGOS concept as specified in CONOPS.

6.2 EC-WG/WIGOS-WIS recognized that CONOPS would continue to be refined as required and remain a basic reference document to the WIGOS Development and Implementation Strategy (WDIS) and the WIGOS Implementation Plan (WIP), which would be developed after Cg-XVI.

6.3 EC-WG/WIGOS-WIS reviewed in detail the submitted version of CONOPS, and agreed on the version (Appendix II) to be submitted to EC-LXII for consideration and endorsement.

7. WIGOS INTRODUCTORY PUBLICATION

7.1 EC-WG/WIGOS-WIS reviewed an updated version of *WIGOS Imperative* (Appendix III) that was developed in accordance with the request by the second session of the EC Working Group on WIGOS and WIS (May 2009). This document should be presented to the permanent representatives of countries with WMO together with other WIGOS related documents such as CONOPS, etc.

7.2 Some participants of EC-WG/WIGOS-WIS expressed their opinions that the document should also include WIGOS objectives and deliverables, provide explanation of the roles of co-sponsored systems and the WMO partnership; some other felt that only minor modification was needed to clarify certain points. After discussion, EC-WG/WIGOS-WIS suggested that it would be useful to have the document available in the following three forms: 1) its current version with minor revision for EC-LXII; 2) an expanded version that will contain the most essential illustration material, including tables, diagrams, figures and flow charts to make the document more user-friendly, and 3) as a PowerPoint presentation.

7.3 EC-WG/WIGOS-WIS agreed that after finalization, the document be presented at EC-LXII to demonstrate how WIGOS will allow NMHSs and other relevant national and international institutions to better fulfil their mandates, including response to natural hazards, hydrological and environmental monitoring, climate observation, and adaptation to climate-change and human-induced environmental impacts in accordance with the WMO strategic planning.

7.4 EC-WG/WIGOS-WIS requested to ensure the consistency between this document and CONOPS and WDIS.

8. STATUS OF IMPLEMENTATION OF THE WIGOS DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP)

8.1 EC-WG/WIGOS-WIS considered the status of WDIP and accomplishments achieved by March 2010 and updated the current phase of WDIP by indicating the status of the actions. The new version of the WDIP (Appendix IV) will be submitted to EC-LXII for consideration and adoption.

8.2 Based on the discussion on the Future Work Programme and Action Plan of EC WG (Item 12), Phase IV. EC-LXII (June 2010) - Cg-XVI (May 2011) was updated accordingly.

9. WIGOS DEVELOPMENT AND IMPLEMENTATION STRATEGY (WDIS)

9.1 EC-WG/WIGOS-WIS welcomed the draft WIGOS Development and Implementation Strategy (WDIS) developed by the Secretariat, in accordance with the recommendations of EC-WG/WIGOS-WIS-2 (May, 2009) and SG-WIGOS-2 (October 2009) and taking into account lessons learned from WIGOS projects and other activities carried out during the WIGOS Test of Concept phase.

9.2 EC-WG/WIGOS-WIS emphasized the importance of this document that describes the steps to be followed by WMO to improve governance, management, and integration of observing systems. WDIS also includes capacity-building requirements and clearly specifies responsibilities across the WMO system for the further development and implementation of WIGOS, addressing coordination and technical challenges of the implementation process.

9.3 EC-WG/WIGOS-WIS agreed that the Strategy must be focused on the implementation of more effective management of the WMO observing systems, including improved governance, as well as establishment of the mechanism and framework for enhanced collaboration and cooperation with WMO partner organizations.

9.4 EC-WG/WIGOS-WIS further agreed that an effective and sustained organizational, programmatic, governance and procedural structure, established by the WIGOS framework, will enable a common standardization approach, uniform implementation of WMO regulations, and data integration and interoperability across all WMO observing systems. It will also provide a single focus for integrated and coordinated operational management of all WMO observing systems and a mechanism for coordination with WMO co-sponsored and contributing observing systems.

9.5 EC-WG/WIGOS-WIS agreed that the long-term commitment and effort of WMO Members, greater international cooperation, and sustained technological, capacity building, and financial support for developing and least developed countries are essential. In addition, central coordination through the WMO Secretariat is crucial for successful WIGOS implementation.

9.6 EC-WG/WIGOS-WIS agreed that the Strategy, to be presented to Cg-XVI, will be a basic reference for preparation of the more detailed WIGOS Implementation Plan to be developed after Cg-XVI.

9.7 EC-WG/WIGOS-WIS reviewed in detail the version of WDIS that had been reviewed and updated by the CBS-CIMO WIGOS coordination meeting, 22-23 March, and agreed on the version (Appendix V) to be submitted to EC-LXII for consideration and endorsement.

10. REPORT ON THE INTEGRATION BETWEEN THE WMO OBSERVING SYSTEMS

10.1 EC-WG/WIGOS-WIS reviewed the draft Report on the Integration of the WMO Observing Systems prepared by the Secretariat and agreed in principle on the layout. EC-WG/WIGOS-WIS recommended that additional sections should appear in the report, including "Enhanced coordination with partner organizations" in "Priority activities for the future". It also recommended that an updated version of the Report should be distributed to the representatives of GCOS, GOOS, GTOS, etc. for comments. The layout of the draft Report on the Integration of the WMO Observing systems as approved by the EC-WG/WIGOS-WIS is reproduced in Annex to this paragraph.

11. RECOMMENDATIONS FOR EC-LXII

11.1 EC-WG/WIGOS-WIS discussed the issues to be submitted to EC-LXII for consideration. Those issues relate to the Implementation of the WIGOS Concept, WIGOS Concept of Operations, WIGOS Development and Implementation Plan, WIGOS Demonstration (WDP) and Pilot Projects (WPP), and WIGOS Development and Implementation Strategy.

WDIP and CONOPS

11.2 EC-WG/WIGOS-WIS requested EC-LXII to adopt the updated versions of the WIGOS Development and Implementation Plan (WDIP) (INF 3.4 (1)) and the WIGOS Concept of Operations (CONOPS) (INF 3.4 (2)), respectively, with the understanding that they might be further refined in view of the lessons learned from the WIGOS Test of Concept Phase.

11.3 In this regard, EC-WG/WIGOS-WIS noted with appreciation the successful completion of most of the tasks specified in WDIP for the individual phases and thanked Members, regional associations and technical commissions for active collaboration in testing and developing the WIGOS concept, and providing their inputs to WDIP. EC-WG/WIGOS-WIS also noted that the current version of CONOPS more adequately covers operational aspects of WIGOS and therefore, more fully meets user expectations.

WIGOS Projects

11.4 EC-WG/WIGOS-WIS noted the progress in the WIGOS Projects. It appreciated the role and input of the relevant technical commissions and AMDAR Panel in initiating and implementing WIGOS Pilot Projects (WPP). EC-WG/WIGOS-WIS also expressed its appreciation for the efforts of Kenya, Morocco and Namibia (RA I), Republic of Korea (RA II), Brazil (RA III), the United States of America (RA IV), Australia (RA V) and the Russian Federation (RA VI) in implementation of their WIGOS Demonstration Projects (WDP).

11.5 EC-WG/WIGOS-WIS acknowledged that some Pilot and Demonstration Projects had not yet been completed. Some projects were designed to be ongoing while some others were unable to be completed because of the need for additional guidance material and standards still to be developed. However, in all cases there were a significant number of lessons learned. In this regard, EC-WG/WIGOS-WIS underlined that these pilot and demonstration projects should continue to be an important activity in the later WIGOS implementation stages, especially in assisting LDCs and SIDS countries to more fully benefit from WIGOS.

11.6 EC-WG/WIGOS-WIS agreed that WDPs and WPPs provided lessons learned, feedbacks and perspectives on the potential benefits, value and impacts of the WIGOS implementation process at the national, regional and technical levels which were necessary for the finalization of CONOPS and WDIS. EC-WG/WIGOS-WIS reaffirmed that the success of the WIGOS process will strongly depend on the collaboration and cooperation among WMO Members as well as among WMO and its partner organizations.

WIGOS Development and Implementation Strategy

11.7 EC-WG/WIGOS-WIS requested the Council to endorse the draft WIGOS Development and Implementation Strategy (WDIS), which was based on the WMO strategic planning, taking into account lessons learned from WIGOS projects and other activities carried out during the WIGOS Test of

Concept phase. It emphasized the importance of this document that describes the steps to be followed by WMO to improve governance, management, and integration of observing systems. WDIS also includes capacity-building requirements and clearly specifies responsibilities across the WMO system for the further development and implementation of WIGOS, addressing coordination and technical challenges of the implementation process.

11.8 EC-WG/WIGOS-WIS underscored that in implementing WIGOS, it is imperative that the current management, governance and support activities be reviewed and aligned with WMO strategic planning and results-based management. This alignment should enable collaboration and promote cooperation and coordination at the technical, operational and administrative levels.

11.9 EC-WG/WIGOS-WIS agreed that central coordination through the WMO Secretariat is important for successful WIGOS implementation. In addition, the long-term commitment and effort of WMO Members; greater international cooperation; and sustained technological, capacity building, and financial support for developing and least developed countries are essential.

11.10 EC-WG/WIGOS-WIS recommended to the Executive Council to request regional associations and technical commissions to incorporate WIGOS implementation activities into their operating plans and work programmes. Further, it requested the Council to encourage regional associations to develop their regional WIGOS implementation plans and coordinate WIGOS implementation activities, as well as to establish WIGOS-related Task Teams and to initiate regionally focused WIGOS-WIS activities.

11.11 EC-WG/WIGOS-WIS agreed that, following the approval by Congress, the WIGOS Implementation Plan (WIP) will be developed in line with the WIGOS Implementation Strategy. The Secretariat will serve as a focal point for these activities.

WIGOS QMF

11.12 EC-WG/WIGOS-WIS further highlighted that 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. WIGOS QMF implementation strategy will specify all processes of QMS for observational networks. Attention will also be paid to the guidance on how to manage observational networks and observing subsystems to more fully meet QMF requirements.

WIGOS Databases

11.13 EC-WG/WIGOS-WIS requested the Council to consider resources needed for development of two WIGOS Databases (DB), i.e. the WIGOS Operational DB and the WIGOS Standardization DB, as specified in CONOPS, as well as significant update of the current User Requirements and Operational Capabilities DB as critical WIGOS framework support tools must be realized during the WIGOS Implementation phase.

Resources

11.14 EC-WG/WIGOS-WIS agreed that the timely completion of the WIGOS Implementation phase in the sixteenth financial period 2012-2015 directly depends on available resources. The investment for fully implementing WIGOS shall be also a significant component of WIGOS development and implementation plans of individual NMHSs.

11.15 EC-WG/WIGOS-WIS noted that to provide the essential Secretariat support during the implementation phase of WIGOS in the sixteenth financial period, CHF 2.4 million for staff and CHF 1.7 million for non-staff expenditures will be needed to support the WIGOS Project Office. The additional cost of translation and publication was not included and will need to be determined in due course. If a lower level of resources is approved for 2012-2015, WIGOS implementation would have to proceed at a slower pace and with a more narrow focus. Therefore, additional budgetary resources may need to be allocated to WIGOS implementation. EC-WG/WIGOS-WIS expressed its concern that

if adequate resources are not available, the full implementation of WIGOS would not be achieved as planned, and, initially, only the most important priorities could be addressed. In this regard, EC-WG/WIGOS-WIS requested the Council to consider carefully resources needed for the WIGOS implementation.

11.16 EC-WG/WIGOS-WIS agreed that since the flexibility for the additional staff requirements is limited within budgetary resources for 2012-2015, the full staffing requirement would need to be met through the secondment of experts from NMHSs. In this connection, EC-WG/WIGOS-WIS requested the Council to urge Members to provide secondment services to the Secretariat during the WIGOS Implementation phase to ensure the successful WIGOS implementation. It strongly felt that additional emphasis in the proposed budget for the sixteenth financial period be placed on the implementation of WIGOS.

Coordination and Partnership

11.17 EC-WG/WIGOS-WIS noted the significance of active cooperation and enhanced coordination among the technical commissions, regional associations, and WMO partner organizations. It underlined that integration activities be included in the work programmes and implementation plans of these entities. EC-WG/WIGOS-WIS proposed to the Council that an Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) with the terms of reference as proposed in WDIS be established for this purpose immediately after Cg-XVI.

11.18 EC-WG/WIGOS-WIS stressed the importance of close alignment of WIGOS and WIS planning and implementation with the development and implementation of the other observing components of the future GFCS to ensure consistency, effectiveness and avoid any duplication.

11.19 EC-WG/WIGOS-WIS agreed that improving coordination within the WIGOS framework should be the high-priority activity at policy, technical, and Secretariat levels. This will need to be supported by the development of a high-level mechanism for coordination with the cosponsored observing systems, such as through the various Memoranda of Understanding among partner organizations, in order to resolve possible problems in data policy, product delivery, and other governance issues. The existing Interagency Coordination and Planning Committee for Earth Observations (ICPC) could be strengthened and used as a high-level coordination mechanism.

11.20 EC-WG/WIGOS-WIS also underlined that through implementation of WIGOS and WIS, WMO will make a fundamental contribution to the success of the UNESCO-IOC, UNEP, FAO and ICSU co-sponsored observing systems and GEOSS.

WMO Technical Regulations

11.21 EC-WG/WIGOS-WIS agreed that the revised structure of WMO Technical Regulations must document the structure and requirements of WIGOS operations, adequately reflecting contributions of all component systems. EC-WG/WIGOS-WIS agreed that upon the approval by Cg-XVI, WIGOS Implementation Plan should include the development of a Manual on WIGOS as a priority activity. EC-WG/WIGOS-WIS requested the Council to endorse the inclusion of the Manual on WIGOS in the list of mandatory publications for consideration by Sixteenth Congress.

Governance

11.22 EC-WG/WIGOS-WIS noted that the development of an effective and efficient system of governance will require adequate scientific and technical advisory mechanisms to develop, monitor, and evaluate the WIGOS implementation process. EC-WG/WIGOS-WIS proposed to the Council to maintain its EC-WG/WIGOS-WIS to steer and monitor WIGOS activities to ensure the broadest possible collaboration and cooperation and to keep in force the Resolution 3 (EC-LIX) Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System.

11.23 EC-WG/WIGOS-WIS requested the Council that the Secretary-General, in close coordination with the chairperson of the EC WG/WIGOS-WIS, should ensure that the necessary follow-up actions

on WIGOS-WIS implementation were taken, including preparation of the comprehensive report for the consideration by Sixteenth Congress.

EC action on WIGOS

11.24 Following the adoption of CONOPS, WDIP and WDIS by EC-LXII, EC-WG/WIGOS-WIS will develop a comprehensive report of the Executive Council to Cg-XVI on the Integration of the WMO Observing Systems.

11.25 EC-WG/WIGOS-WIS agreed to submit to the Executive Council a Draft Resolution 3.4/3 (EC-LXII) "Implementation of WIGOS" (Appendix VI).

12. FUTURE WORK PROGRAMME AND ACTION PLAN OF EC WG

12.1 Based on the results of discussion under various agenda items, EC-WG/WIGOS-WIS agreed on the major tasks for its Work programme and Action Plan for steering and monitoring the WIGOS and WIS activities until its next session in 2011 prior to Cg-XVI.

12.2 Planned actions relate to the overall implementation of the WIGOS Development and Implementation Plan, Demonstration and Pilot Projects, Concept of Operations, and WIGOS Development and Implementation Strategy. The WIGOS Planning Office and WIS Project Office were tasked to regularly monitor the progress achieved and keep informed chairs of EC WG, SG-WIGOS and ICG-WIS, respectively, facilitating to take actions as appropriate.

12.3 The Work Programme and Action Plan of the EC-WG/WIGOS-WIS for the period from April 2010 to April 2011 as approved by the session is reproduced in the Appendix VII.

13. ANY OTHER BUSINESS

13.1 The session considered the current activities being coordinated between CBS, CAeM and ICAO in support of developing and new requirements for managing aviation Operational Meteorological (OPMET) information, in particular from the focus of observations, WIGOS, and information management systems, WIS. The President of CBS and the secretariat provided an overview of the issues and activities and their relationship to WIS and WIGOS. Particular focus was placed on the NextGen program in North America and the Single European Skies initiative. Recognizing the importance of these issues to the Members, EC-WG/WIGOS-WIS supported the continued engagement of the Commissions in this matter and requested to be kept abreast on the progress.

13.2 The president of CBS presented a proposed WIGOS logo (see Figure below). Comments expressed during the discussion included: the value of having a WIGOS logo to sit alongside the GOOS and GTOS logos when presenting cross-cutting observing systems such as GCOS and GEOSS; to have alternative logos to ensure the best choice; to ensure that the logo should be simple as much as possible and easily interpreted including colours used. EC-WG/WIGOS-WIS welcomed the initiative to have a WIGOS Logo and requested to coordinate its design in consultation with all concerned.

Figure: Possible WIGOS logo

14. CLOSURE OF THE SESSION

14.1 The session closed at 16:10 hours on Friday, 26 March 2010.

Appendix I

LIST OF PARTICIPANTS

Prof. A. Divino Moura **(Brazil, RA III)** Chair	Instituto Nacional de Meteorología (INMET) Eixo Monumental Via S-1 Sudoeste BRASILIA, DF CEP 70680-900 Brazil Tel.: +55 61 33 443 333 Fax.: +55 61 33 440 700 E-mail: diretor.inmet@inmet.gov.br
Mr Tyrone W. Sutherland (British Caribbean Territories, RA IV)	Caribbean Meteorological Organization 27 O'Connor Street, Woodbrook, P.O. Box 461 PORT OF SPAIN Trinidad and Tobago Tel.: +1868 622 4711 Fax.: +1868 622 0277 E-mail: Tsutherland@cmo.org.tt Suthcmo@tstt.net.tt
Dr Anthony C. Anuforom (Nigeria, RA I)	Nigerian meteorological Agency 33 Pope John Paul II Street MAITAMA, ABUJA, Nigeria Tel: +2348 8135 354 559 Fax: +2347 7064 187 400 Email: tonycanuforom@yahoo.com
Dr Joseph Romanus Mukabana (Kenya, RAI)	Kenya Meteorological Department Dagoretti Corner, Ngong Road P.O. Box 30259 00100 GPO NAIROBI Kenya Tel.: +254 20 3867 880-5 Fax.: +254 20 387 6955 E-mail: director@meteo.go.ke; mukabana@meteo.go.ke Cc: maingi@meteo.go.ke
Mr Franz Uirab (Namibia, RA I)	Meteorological Services Private Bag 13224 WINDHOEK 9000 Namibia Tel.: +264 61 287 7001 Fax.: +264 61 287 7009 E-mail: fuirab@meteona.com, somsess@meteona.com
Mr **Zhao** Datong *(representing Dr Zheng Guoguang)* (China, RA II)	China Meteorological Administration 46, Zhongguancun Nandajie Haidian District BEIJING 100081 China Tel: +8610 5899 5027 Fax: +8610 6217 4797 Email zhaodt@cma.gov.cn

Dr Masashi Nagata, representing **Mr Kunio Sakurai** *(Japan, RA II)* *and* **Mr Hakaru Mizuno** *(Advisor)*	Japan Meteorological Agency 1-3-4 Otemachi, Chiyoda-ku TOKYO 100-8122 Japan Tel: +81 3 3212 8341 (x3103) Fax: +81 3 3284 0180 Email: mnagata@met.kishou.go.jp mizuno.hakaru@met.kishou.go.jp
Lic. Juan Manuel Hörler (representing Dr Héctor Horacio Ciappesoni, Argentina, RA III)	Servicio Meteológico Nacional 25 de Mayo 658 C1002 ABN Ciudad Autónomo de BUENOS AIRES Argentina Tel.: +54 11 5167 6712 Fax.: +54 11 5167 6709 E-mail: jhorler@smn.gov.ar susyb@smn.gov.ar
Mr Fredrick R. Branski (representing Dr J. Hayes, US, Region IV, and CBS)	NOAA – National Weather Service (W/CIO11) SSMC2, Room 17456 1325 East West Highway SILVER SPRING, Maryland 20910-3283 USA Tel: +1 301 713 3538 Ext. 121 Fax: +1 301 713 9450 E-mail: Fred.Branski@noaa.gov
Brigaier General Massimo Capaldo (Italy, RA VI)	Aeronautica Militare Stato Maggiore – USAM Viale dell'Universita 4 I-00185 ROMA Italy Tel.: +39 06 4986 7002 Fax.: +39 06 4986 7052 Email: m.capaldo@meteoam.it
Mr Marek Janiec (representing Prof. Mieczyslaw S. Ostojski, Poland, RA VI)	Institute of Meteorology and Water Management Ul. Podlesna 61 01-673 WARSAW Poland Tel: +48 (22) 5694 354 Fax: +48 (22) 5694 105 Email: Marek.Janiec@imgw.pl
Prof. Geerd Rüdiger Hoffmann *(representing Inter-Commission Coordination Group on WIS)*	Deutscher Wetterdienst P.O. Box 100 465 63067 OFFENBACH Germany Tel.: +(49 69) 8062 2824 Fax.: +(49 69) 8062 5217 E-mail: geerd-ruediger.hoffmann@dwd.de
Dr Sue L. Barrell *(representing CBS)*	Bureau of Meteorology G.P.O. Box 1289 MELBOURNE, VIC 3001 Australia Tel: +(61 3) 9669 4222 Fax: +(61 3) 9669 4168 Email: s.barrell@bom.gov.au

Dr Jörg Klausen *(representing CAS)*	GAW QA/SAC Switzerland Überlandstrasse 129 CH-8600 Dübendorf, Switzerland E-Mail: joerg.klausen@empa.ch Phone: +41 44 823 4127 Fax: +41 44 821 6244 Email: Joerg.Klausen@empa.ch
Dr John Zillman *(representing GCOS)*	GPO Box 1289K MELBOURNE, VIC. 3001 Australia Tel: +613 9669 4250 Fax : +613 9669 4169 E-mail : j.zillman@bom.gov.au
Dr Keith Alverson *(representing GOOS and IOC UNESCO)*	Chief of Ocean Observations and Services, IOC/UNESCO Director, Global Ocean Observing System 1 rue Miollis 75732 Paris Cedex 15 France Tel: +33 (0) 1 45 68 40 42 Fax: +33 (0) 1 45 68 58 13 Email: k.alverson@unesco.org
Mr Frank Grooters (representing AMDAR)	Royal Netherlands Meteorological Institute Wilhelminalaan 10 P.O. Box 201 3730 AE De Bilt The Netherlands Tel: +31 302 206 691 Fax: +31 302 211 195 E-mail: frank.grooters@knmi.nl
WMO SECRETARIAT 7 bis, avenue de la Paix CH-1211 Geneva 2 Switzerland	**WWW Programme website** http://www.wmo.int/pages/prog/www/index_en.html
Dr Wenjian Zhang	Director Observing and Information Systems Department Tel.: +41 22 7308 567 Fax.: +41 22 7308 021 E-mail: WZhang@wmo.int
Ms Barbara Ryan	D/SAT Observing and Information Systems Department Tel.: +41 22 7308 285 Fax.: +41 22 7308 021 E-mail: BRyan@wmo.int
Dr (Ms) Carolin Richter	D/GCOS Observing and Information Systems Department Tel.: +41 22 7308 275 Fax.: +41 22 7308 052 E-mail: CRichter@wmo.int
Mr Peiliang Shi	D/WIS Observing and Information Systems Department Tel.: +41 22 7308 219 Fax.: +41 22 7308 021 E-mail: PShi@wmo.int

Dr Igor Zahumensky	WIGOS Planning Office Observing and Information Systems Department Tel.: +41 22 7308 277 Fax.: +41 22 7308 021 E-mail: IZahumensky@wmo.int
Dr Miroslav Ondras	Chief, Observing System Division Observing and Information Systems Department Tel.: +41-22 7308 409 Fax.: +41-22 7308 021 E-mail: MOndras@wmo.int
Mr David Thomas	WIS Project Manager, WIS Branch Observing and Information Systems Department Tel.: +41 22 7308 241 Fax.: +41 22 7308 021 E-mail: DThomas@wmo.int
Mr Etienne Charpentier	Scientific Officer Observing and Information Systems Department Observing System Division Tel.: +41 22 7308 223 Fax.: +41 22 7308 128 E-mail.: ECharpentier@wmo.int
Mr Michael Berechree	Scientific Officer Observing and Information Systems Department Observing System Division Tel.: +41 22 7308 212 Fax.: +41 22 7308 021 E-mail: MBerechree@wmo.int
Dr James PURDOM	WMO Senior Consultant Tel.: Fax.: +41 22 7308 021 Email.: Purdom@cira.colostate.edu
Dr Alexander KARPOV	WMO Consultant Tel.: +41 22 7308 436 Fax.: +41 22 7308 021 Email.: AKarpov@wmo.int

Appendix II

WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

CONCEPT OF OPERATIONS (CONOPS)

Version 4.1.4

APPROVAL PAGE

WIGOS CONOPS intends to contribute to the implementation activities under the following WMO STRATEGIC THRUSTS:

I. Improving Service Quality and Service Delivery

II. Advancing Scientific Research and Applications as well as Development and Implementation of Technology

III. Strengthening Capacity Building

IV. Building and Enhancing Partnerships and Cooperation

V. Strengthening Good Governance

and specifically, to the implementation of the Organization-wide Expected Result 4:

Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable surface-based and space-based systems for weather, climate and hydrological observations, as well as related environmental observations, based on world standards set by WMO and partner organizations.

WIGOS CONOPS RELEASE APPROVAL (Date): *DD-MM- 2010*

BODY: WMO EXECUTIVE COUNCIL (EC- LXII, paragraph *XYZ* **of the General Summary)**

DOCUMENT VERSION CONTROL

Version	Author(s)	Date	Description
0.1	Ondras, Dombrowsky	Dec 2007	Draft for review by EC-WG/WIGOS-WIS-1
0.1			Feedback from EC-WG/WIGOS-WIS-1 (no changes)
1.0		June 2008	Draft for consideration by EC-LX
1.0			Feedback from EC-LX (no changes)
2.0	WIGOS-PO	Nov 2008	Draft for the review by SG-WIGOS-1
2.1			Feedback from SG-WIGOS-1 (deep review)
2.2	WIGOS-PO	May 2009	Draft for review by EC-WG/WIGOS-WIS-2
2.3	WIGOS-PO	May 2009	Feedback from EC-WG/WIGOS-WIS-2 (Part 5.4 elaborated)
3.0	WIGOS-PO	June 2009	Draft for consideration by EC-LXI
3.0			Feedback from EC-LXI (no changes)
4.0	WIGOS-PO	Oct 2009	Draft for the review by SG-WIGOS-2 (significant change of the structure; addition of new text)
4.1.0	WIGOS-PO	Oct 2009	Feedback from SG-WIGOS-2 (editorial changes)
4.1.1	WIGOS-PO	March 2010	Consistency with WDIS
4.1.2	CBS/CIMO	March 2010	Feedback from CBS-CIMO/WIGOS-CM
4.1.3	EC-WG	March 2010	Decision by EC-WG/WIGOS-WIS-3
4.1.4	WIGOS-PO	April 2010	Feedback from EC-WG/WIGOS-WIS

CONTENTS

1 SCOPE OF DOCUMENT 5
1.1 IDENTIFICATION OF CONOPS 5
1.2 CONOPS DOCUMENT PURPOSE 5
1.3 WIGOS OVERVIEW 5
1.3.1 BACKGROUND 5
1.3.2 VISION 5
1.3.3 PURPOSE 6
1.3.4 INTEGRATION 6
1.3.5 GENERAL CHARACTERISTICS 6
1.3.6 BENEFITS 6
2 REFERENCED DOCUMENTS 7
2.1 REPORTS OF WMO CONSTITUENT BODIES 7
2.2 WMO REGULATORY MATERIAL AND INTERNATIONAL STANDARDS 8
2.3 OTHER RELEVANT DOCUMENTATION 8
3 CURRENT WMO AND CO-SPONSORED OBSERVING SYSTEMS 9
3.1 DESCRIPTION OF EXISTING SYSTEMS 9
3.2 OPERATIONAL POLICIES 9
3.3 CLASSES OF USERS AND APPLICATION AREAS 10
4 JUSTIFICATION FOR INTRODUCTION OF WIGOS AND DESCRIPTION OF CHANGES NEEDED 10
4.1 JUSTIFICATION OF CHANGES 10
4.2 DESCRIPTION OF EXPECTATIONS AND DESIRED CHANGES 11
4.3 PRIORITIES AMONG CHANGES 12
4.3.1 ESSENTIAL CHANGES 12
4.3.2 DESIRABLE CHANGES 13
4.4 CONSOLIDATION AND COST BENEFITS 13
4.5 TECHNOLOGY IMPROVEMENTS 13
5 WIGOS CONCEPT 14
5.1 OBJECTIVES AND SCOPE 14
5.2 KEY ELEMENTS OF THE OPERATIONAL WIGOS 14
5.2.1 INTEGRATION, STANDARDIZATION AND INTEROPERABILITY 15
5.2.2 STANDARDIZATION OF INSTRUMENTS AND METHODS OF OBSERVATION 15
5.2.3 WIS INFORMATION DISCOVERY AND EXCHANGE 15
5.2.4 QUALITY MANAGEMENT FRAMEWORK 15
5.2.5 ROLLING REVIEW OF REQUIREMENTS (RRR) PROCESS AND EVOLUTION OF OBSERVING SYSTEMS 16
5.2.6 OPERATIONAL DATABASE 17
5.2.7 STANDARDIZATION DATABASE 18
5.2.8 ROLES AND RESPONSIBILITIES 18
5.2.9 GOVERNANCE 19
5.2.10 RESOURCES 20
5.3 PRINCIPLES AND ASSUMPTIONS 20
6.1 DATA POLICY 21
6.2 RELATIONSHIP WITH THE WMO AND CO-SPONSORED OBSERVING SYSTEMS 22
6.3 SCIENCE SUPPORT 22
7 IMPACTS AND IMPLICATIONS 23
7.1 IMPACTS ON WMO 23
7.2 OPERATIONAL IMPACTS 23
7.3 CHALLENGES 24
7.4 RISKS 24
8 LIST OF ACRONYMS 25

1 SCOPE OF DOCUMENT

1.1 Identification of CONOPS

In accordance with international standards, the Concept of Operations (CONOPS) is a user-oriented document that describes characteristics of the to-be-delivered system from an integrated viewpoint. The CONOPS document also describes user needs for and expectations from the proposed system and how the system should operate to fulfil those needs.

The ideas expressed in this WMO Integrated Global Observing System (WIGOS) Concept of Operations document are the results of analyzing the challenges involved in the implementation of the WMO integration strategy endorsed by the Fifteenth World Meteorological Congress in 2007.

To guide the transition of WIGOS during the Test of Concept phase, the WIGOS Development and Implementation Plan (WDIP) was adopted by the Executive Council. It was also determined that CONOPS document should be considered as the constituent part of WDIP. Furthermore, in accordance with a decision of EC-LXI, the WIGOS Development and Implementation Strategy (WDIS) was developed.

1.2 CONOPS Document purpose

The purpose of this CONOPS document is to describe the WIGOS concept. It serves as a basic means to communicate the high-level quantitative and qualitative characteristics of WIGOS to the user community within and outside of WMO and other stakeholders at the national and international levels.

Users might read the CONOPS document to determine whether their needs and expectations have been correctly identified, while the developers will typically use this document as a basis for WIGOS development and implementation activities described further in WDIP.

1.3 WIGOS overview

1.3.1 Background

Various observing systems throughout WMO Programmes and WMO partner organizations have been developed, funded, managed and operated to meet their own specific purposes. By adopting the WIGOS strategy, the Fifteenth World Meteorological Congress wished to establish a comprehensive, coordinated and sustainable system of observing systems in order to satisfy evolving observational requirements of WMO and WMO co-sponsored Programmes in a cost-effective manner.

1.3.2 Vision

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 WMO Members in delivering their weather, climate, water and related environmental services. WIGOS will enhance the coordination of the WMO observing systems with those of partner organizations[1)] for the benefit of society.

WIGOS will be a framework enabling the integration and optimized evolution of WMO observing systems, and of WMO's contribution to co-sponsored systems. Together with 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 activities.

[1)] In this document "partner organizations" means: Intergovernmental, non-governmental and international organizations and groupings that operate, or co-sponsor, with WMO, observing systems that contribute to WIGOS. The main partner organizations are UNESCO and its IOC, UNEP, FAO and ICSU and the main co-sponsored observing systems are GCOS, GOOS and GTOS; partner organizations also include GEO.

1.3.3 Purpose

The purpose of WIGOS is to provide an effective and sustainable organizational, programmatic, governance and procedural structure that will significantly improve the availability, usefulness**,** quality and utilization of observational data and products through a single focus for the operational and management functions of all WMO observing systems as well as a mechanism for interactions with WMO co-sponsored observing systems.

WIGOS will allow WMO Members' NMHSs and other relevant national and international institutions to better fulfil their mandates, including response to natural hazards, hydrological and environmental monitoring, climate observation, and adaptation to climate-change and human-induced environmental impacts.

1.3.4 Integration

Following the guidelines by Cg-XV, integration in the context of WIGOS should be defined as joint efforts by data users and data producers at the national and international levels to establish a comprehensive, coordinated and sustainable system of observing systems, ensuring interoperability between its component systems. It will be a framework facilitating standardization and interoperability and ensuring availability and utilization of, and access to, good-quality data and products, and associated metadata. The integration process should encompass the following:

(a) Addressing the needs of the atmospheric, hydrologic, oceanographic, cryospheric and terrestrial domains within the operational scope of a comprehensive integrated system through standardization and network optimization;

(b) Increasing interoperability between systems with particular attention given to space-based and *in-situ* components of the systems;

(c) Ensuring that broader governance frameworks (e.g. inter-agency co-sponsored systems) and relationships with other international entities are sustained and strengthened;

(d) Improving WMO management and governance (use of resources, planning, institutional and programme structures, and monitoring).

1.3.5 General characteristics

Resolution 30 (Cg-XV) recognized WIGOS as a major effort of the Organization. Its development should proceed concurrently with the planning and implementation of the WMO Information System (WIS). The combination of both efforts will allow for an integrated WMO end-to-end system of systems designed to improve Members' capability to effectively provide a wide range of high quality services and to better serve all WMO Programmes requirements.

WIGOS will build on and add value to the WMO's existing observing systems by coordinating their efforts, addressing shortcomings, and supporting their interoperability, while satisfying the observational requirements of WMO and WMO co-sponsored Programmes in a cost-effective manner.

WIGOS will provide a 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 will work with partner organizations to achieve maximum commonality of standards and practices across the co-sponsored observing systems.

Congress stressed that this endeavour would have an impact on the structure and functions of WMO, the WMO Programme structure, roles, terms of reference and working arrangements of technical commissions, the WMO Technical Regulations, and the WMO Secretariat.

1.3.6 Benefits

In order to meet the evolving needs of WMO Members, there is a well-recognized need to improve existing observing capability, make it more cost-effective, sustain its operation and enhance service delivery. Integration of respective components and systems must be pursued to ensure interoperability, and optimize constituent observing systems within a WIGOS framework. WIGOS will also enable resources to be used more efficiently and effectively to overcome existing deficiencies and gaps.

WIGOS is expected to provide timely, quality-assured, quality-controlled and well-documented long-term observations. Implementing Quality Management procedures will be required to enable enhanced utilization of both existing and emerging observational capabilities. In meeting the evolving user requirements, WIGOS, together with WIS, will:

- Enable the evolution and integration of WMO observing systems and enhance collaboration with its partner organizations: this will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services (across weather, water and climate domains) in a cost-effective manner;
- Result in enhanced observing capabilities by improving interoperability and coordination between its surface- and space-based components;
- Enable WMO Members to meet expanding national mandates which are calling for increasing coordination and integration to help them better respond to natural hazards, improve weather, water, climate and related environmental monitoring, and adapt to climate change and other human-induced environmental impacts;
- Enhance operational components of WMO Programmes, especially in Developing and Least Developed Countries and ensure essential WMO support for the observational and information elements of the future Global Framework for Climate Services (GFCS);
- Contribute strongly to GOOS, GTOS, and GCOS, and to the Global Earth Observation System of Systems (GEOSS); and
- Provide a basis for sound decision making and enhance delivery of services to society.

An integrated global observing system, supported by an interoperable information system, will be essential for realizing the socio-economic benefits from the wide range of weather, climate, water and related environmental products and services, based on WMO's core competencies in environmental monitoring.

WIGOS will be an essential component of WMO's results-based management. It will ensure a coordinated WMO contribution to the cosponsored GOOS and GTOS and will be key to the successful implementation of GCOS in support of the UNFCCC, and in the development and implementation of the future Global Framework for Climate Services (GFCS). Through WIGOS and WIS, and their support for GOOS, GTOS and GCOS, WMO will make a fundamental contribution to the success of the Global Earth Observation System of Systems (GEOSS).

2 REFERENCED DOCUMENTS

The following documentation was used to support the generation of this document.

2.1 Reports of WMO Constituent bodies

- Fifteenth World Meteorological Congress, Abridged final report with resolutions (WMO-No. 1026)
- EC-LVIII, Abridged final report with resolutions (WMO-No. 1007)
- EC-LIX, Abridged final report with resolutions (WMO-No. 1027)
- EC-LX, Abridged final report with resolutions (WMO-No. 1032)
- EC-LXI, Abridged final report with resolutions (WMO-No. 1042)
- CBS-XIV, Abridged final report with resolutions and recommendations (*in press*)
- Final report of the 1st session of the EC WG on WIGOS-WIS (December, 2007)

- Final report of the 2nd session of the EC WG on WIGOS-WIS (May, 2009)
- Final report of the 1st session of the Subgroup on WIGOS of the EC WG on WIGOS-WIS (November, 2008)
- Final report of the 2nd session of the Subgroup on WIGOS of the EC WG on WIGOS-WIS (October, 2009)

2.2 WMO regulatory material and International Standards

- Basic Documents, No. 1, 2007 edition (WMO-No. 15)
- Technical Regulations (WMO-No. 49)
- Manual on the Global Observing System (WMO-No. 544)
- Manual on the Global Telecommunication System (WMO-No. 386)
- Manual on Codes (WMO-No. 306)
- Manual on the Global Data Processing and Forecasting System (WMO-No. 485)
- Weather Reporting, Volume A (WMO-No. 9)
- Guide to the Global Observing System (WMO-No. 488)
- Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8)
- Global Atmosphere Watch Measurements Guide (WMO-No. 143)
- Guide to Marine Meteorological Services (WMO-No. 471)
- Guide to Agricultural Meteorological Practices (WMO-No. 134)
- Guide to Climatological Practices (WMO-No. 100)
- Guidelines on the Role, Operation and Management of National Hydrological Services (WMO-No. 1003)
- WHYCOS Guidelines (WMO/TD-No. 1282)
- ISO 14001 Environmental Management Systems
- ISO 9001 2008 Quality Management Requirements

2.3 Other relevant documentation

- Vision for the GOS in 2025 (CBS-XIV, 2009)
- WIS Project and Implementation Plan (v. 1.2, February, 2010)
- Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS-92, WMO/TD-No. 1219)
- Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update, Draft v.10)
- GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options (GCOS-112, WMO/TD-No. 1379)
- WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008-2015 (WMO/TD No. 1384)
- Implementation Plan for Evolution of Space-and Surface-based Subsystems of the Global Observing system (WMO/TD-No. 1267)
- CBS TECO-WIGOS Conference Statement (March, 2009)
- WIGOS as a Challenging Initiative of WMO, Keynote by T. Sutherland, Second Vice-President of WMO (CBS TECO-WIGOS, March 2009)
- The first U.S. Integrated Ocean Observing System (IOOS) Development Plan, Washington, DC, January 2006
- Global Earth Observation System of Systems GEOSS 10-Year Implementation Plan (GEO 1000, February 2005)
- GEO 2009-2011 Work Plan (January 2009)
- IEEE Guide for information Technology- System Definition –Concept of Operations (CONOPS) Document, 1988

- NOAA Concept of Operations (CONOPS) for NPOESS Data Exploitation (NDE), 2006
- Concept of Operations (CONOPS) for the National Archives and Records Administration Electronic Records Archives Program Management Office (NARA ERA PMO), 2004
- EUCOS programme management documentation
- THORPEX International Research Implementation Plan (WMO/TD-No.1258)
- Proceedings of the Third WMO Workshop on the Impact of Various Observing Systems on NWP, Alpbach, Austria, 9-12 March 2004
- Proceedings of the Fourth WMO Workshop on the Impact of Various Observing Systems on NWP, Geneva, Switzerland, 19-21 May 2008
- JCOMM Observing System Implementation Goals for Building a Sustained Global Ocean Observing System in Support of the Global Earth Observation System of Systems (2009)
- CIMO Management Group, Seventh Session, Geneva, Switzerland, 15 - 19 February 2010
- CBS Management Group, Eleventh Session, Geneva, Switzerland, 17 - 19 March 2010

3 CURRENT WMO AND CO-SPONSORED OBSERVING SYSTEMS

3.1 Description of Existing Systems

Currently, WMO and co-sponsored observing systems are organized as multiple systems comprising:

(a) Surface-based component of the Global Observing System (GOS) of the World Weather Watch (WWW) Programme;

(b) Space-based component of the GOS, including the geostationary meteorological satellite constellation, the core polar-orbiting meteorological constellation and R&D earth observation satellites;

(c) Aircraft Meteorological Data Relay (AMDAR) systems including expansions of aircraft measurement capabilities for atmospheric composition constituents;

(d) Marine meteorological and relevant oceanographic observing networks of the Global Ocean Observing System (GOOS);

(e) Relevant components of atmospheric, oceanographic and terrestrial observing systems contributing to the Global Climate Observing System (GCOS);

(f) Relevant terrestrial networks of the Global Terrestrial Observing System (GTOS);

(g) Regional, river basin and global hydrological networks such as the World Hydrological Cycle Observing System (WHYCOS);

(h) Global Atmosphere Watch (GAW) networks and systems for observation of atmospheric chemical composition and related environmental parameters;

(i) Various radiation networks;

(j) The observing component of the proposed Global Cryosphere Watch (GCW) approved by the fifteenth WMO Congress;

3.2 Operational Policies

Current WMO and co-sponsored observing systems are generally designed to meet the need for monitoring the state and composition of the atmosphere, land and ocean on global, regional and national scales. The resulting data and information, as well as the forecasts and warnings generated are internationally exchanged. Such information is required to improve understanding of the behaviour of the atmosphere and its interaction with land, oceans and biosphere to enable prediction of the future states of the Earth system.

With respect to the implementation of the above WMO and co-sponsored observing systems, the guiding principle is that all activities and facilities connected with the establishment and operation of

observing network(s) on the territories of individual countries are the responsibility of the countries themselves and should be met to the extent possible from national resources. Where this is not possible, assistance may be provided through multilateral (regional) or bilateral cooperation programmes.

Implementation of certain observing systems outside the territories of individual countries (e.g. outer space, the oceans and the Antarctic) is based on the principle of voluntary participation of countries that desire and are able to contribute by providing facilities and services either individually or jointly from their national resources or through collective financing.

3.3 Classes of Users and Application areas

NMHSs continue to be the principal owners/operators[2)] and major users of data and information generated by the existing observing systems mentioned above. However, the user community is also represented by a growing diversity of stakeholders and decision makers, including national agencies, academia, non-governmental organization, public and private sectors and other societal areas. Depending on the observational data requirements and services provided, the end-user is affiliated to and represents the following (a) socioeconomic sectors and (b) activities of NMHSs:

(a) Agriculture and food production; Aviation; Land transport; Maritime transport; Marine resources; Water resources; Industry; Disaster mitigation and prevention, emergency response; and Energy;

(b) Weather analysis and forecast, including early warning; Marine weather and oceanographic services; Hydrology; Environmental monitoring; Public weather services, health and safety; Climatology and climate services.

Furthermore, the Statement of Guidance (SOG) for each of the application areas below has been developed and updated by the CBS OPAG IOS through the Rolling Requirements Review Process (see section 5.2.5):

- Global Numerical Weather Prediction
- Regional Numerical Weather Prediction
- Synoptic meteorology
- Nowcasting and Very Short Range Forecasting
- Seasonal and Inter-annual Forecasts
- Atmospheric chemistry
- Aeronautical Meteorology
- Ocean Applications
- Climate monitoring
- Climate applications
- Hydrology
- Agricultural meteorology

It is expected that above application areas will be expanded to cover evolving WIGOS user requirements such as GCW, Space Weather.

4 JUSTIFICATION FOR INTRODUCTION OF WIGOS AND DESCRIPTION OF CHANGES NEEDED

4.1 Justification of changes

[2)] This is more likely the case for surface-based systems; only a smaller number of NMHSs own/operate space-based observing systems directly.

An increasingly complex society and sophisticated user community, reflected by rapid economic and industrial development, coupled with increased knowledge of the planet as an integrated system and the changing Earth's climate has resulted in greater vulnerability of nations to extreme weather events and climate change. This has resulted in the need for timely, more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members need to continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase the scientific understanding of the Earth and its environment: the end result being better prediction and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

Historically however, various WMO and WMO co-sponsored Programmes, involving observing systems, have not been developed in a coordinated, integrated manner but have been managed, funded and operated separately to meet their own purposes and goals. Under these arrangements it was not possible to standardize different observing practices including dissemination and processing of data, which is now crucial to effectively respond to rapidly evolving user requirements mentioned above. Also, WMO regulatory material was not harmonized accordingly to assure clear and transparent guidance for Members. These factors seriously hampered the evolution of WMO observing systems in a cost-effective manner. Coordination of observing programmes with partner organizations was also not sufficient.

In the view of the above, a proposed integration of existing observing systems is a necessary prerequisite to allow WMO Members to realize the strategic thrusts of WMO which are:

- Improving service quality and service delivery.
- Advancing scientific research and application as well as development and implementation of technology.
- Strengthening capacity building.
- Building and enhance partnerships and cooperation.
- Strengthening good governance.

WIGOS, endorsed by the Fifteenth WMO Congress, is a major contribution of WMO to the challenges outlined above. The WMO Congress decided that the enhanced integration of the WMO observing systems should be pursued as a strategic objective of WMO and identified this as a major expected result of the WMO strategic plan.

4.2 Description of expectations and desired changes

WMO and co-sponsored observational programmes aim to improve and sustain environmental observations (see Chapter 3). However, along with the progress in accomplishing general tasks mentioned in Section 4.1, current efforts in some regions are still limited, for example, by the following:

- Uncertainty about continuity of observations
- Large spatial and temporal gaps in specific data sets
- Lack of relevant processing systems to transform data into useful information
- Insufficient long term data archiving
- Eroding technical and organizational infrastructure
- Inadequate user involvement
- Lack of access to data and associated benefits, especially in least developed countries
- Inadequate data integration and interoperability
- Insufficient coordination and data sharing among Members, Organizations and Programmes

Therefore, to bring the current observing systems in line with the evolving requirements, the desired changes should encompass activities to address at least the above factors with a goal to minimize

their effects. In this way WIGOS will provide the opportunity to better utilize existing and emerging observation capabilities, thus facilitating accomplishment of required changes. In particular, it is expected that WIGOS will:

- Develop strategies to guarantee systems interoperability, including meeting documented standards for data quality of observing systems and instruments;
- Evaluate existing and emerging capabilities before developing, acquiring, and/or deploying new observing systems or sensors, and in the design of cost-effective composite observing systems;
- Develop strategies to satisfy observational requirements of WMO Programmes and international partners through the WMO Rolling Requirements Review Process;
- Develop a strategy for the production, editing and management of metadata, including instrumentation/platform and data discovery;
- Promote exploitation of existing platforms and employment of the multi-sensor platform concept to the maximum possible extent; and
- Coordinate the response to requirements, plans and activities with all WMO technical commissions, regional associations and Programmes.

Within the WIGOS framework, observational data, metadata and processed observational products from WMO and, to the extent possible, co-sponsored observing systems will:

- Adhere ultimately to WIGOS standards for instruments and methods of observation as well as standard observing network practices and procedures;
- Be exchanged via WIS using agreed upon data and metadata representation forms and formats;
- Use hardware and software that are compatible with WIGOS requirements;
- Be archived in compliance with WIGOS/WIS requirements.

WIGOS will consolidate the roles of WMO observing systems. However, it should be well recognized and understood that WIGOS is not a consolidation of the roles of WMO partner observing systems. Thus, WIGOS should be considered as a framework for recognition and agreement of WMO and its partners concerning each observing system's contributions and responsibilities.

4.3 Priorities among changes

Classifying the changes and new features into *essential and desirable* categories is important to guide the decision making process during the development and implementation of WIGOS.

4.3.1 Essential changes

Features that ***should*** be provided by the new or modified observing system(s) are as follows:

- Enhanced capability to meet all WMO Programmes' requirements in the most cost-effective approach, reducing the financial burden on Members while maximizing administrative and operational efficiency and effectiveness.
- Ensured observing systems interoperability, data compatibility and traceability of observations from all WIGOS constituent observing systems;
- QMS implemented according to WMO Programme requirements by data producers/owners of observing systems/networks;
- Improved access in real-time, near-real-time and delayed mode to wider range of observations required to meet the needs of Members through WMO and WMO co-sponsored programmes, as well as relevant international conventions;
- Improved metadata, data management, archival and data retrieval capabilities;
- More efficient delivery of observational data and products to users;
- Strengthened capability of all Member countries to access and utilize observations from all WMO

and co-sponsored observing systems;

4.3.2 Desirable changes

Features that ***could*** be provided by the new or modified system(s) are as follows:

- The optimum integration of the various components of all observing programmes;
- Capability to effectively adjust and respond to changing requirements;
- Facilitated technological innovation opportunities;
- Improved collaboration with instrument manufacturers and scientific/research institutes in the development and testing of next generation observation instruments.
- Improved production, use and application of data and information from across all WMO and co-sponsored observing systems, in a seamless way, to satisfy user requirements;
- More rapid and effective assimilation of technological advances and their application across all observing programmes;
- Sharing observing platforms as far as practical to reduce redundancies.

4.4 Consolidation and Cost benefits

WIGOS will support the establishment of an evolving optimized observing network(s) within a region(s) which results in a shared work load for the participating NMHSs along with enhanced capabilities and a fair cost allocation. WIGOS, inter-alia, will use experiences gained by regional observing programmes such as the EUCOS (EUMETNET Composite Observing System) Programme, which has helped eliminate duplications of effort in the upper air and surface observing components operated by NMHSs and ensured that the quality of all data delivered by the EUCOS networks has been maintained at a high level. In doing so, the WIGOS framework will significantly enhance those capabilities of Members which they may not have been able to deliver on a national basis.

To move WIGOS forward in a cost-effective manner and to overcome differences in levels of development of national and regional systems and services, it will be required to develop Regional WIGOS Implementation Strategies that take into account, among other things, how Members within Regions can most effectively work together. Also, it is expected to develop regional cooperation programmes like EUCOS which has already demonstrated very promising results for the testing of new observing strategies and indicated ways towards optimization. For the benefit of WIGOS, it will be also of great importance to exploit the lessons learned from the Data Buoy Cooperation Panel, where WMO and IOC as co-sponsors work together to coordinate a more robust and cost-effective observing system.

4.5 Technology improvements

Technological advances will be a crucial factor leading to improvement in sensors and system capabilities to accurately measure environmental variables. These advances will also allow their ability to withstand severe climate and environmental conditions. Progress in technology will continue to provide a basis for further improvements in the reliability and quality of observations, thus more fully satisfying user needs. Based on the above, within the WIGOS framework, the following areas need to be addressed: Standardization, Automation, Testing, and Network design.

Standardization will address best procedures and practices, including quality assurance, data and metadata formats for new and emerging technologies. Standardization is necessary for all data and associated metadata so that the measurements from individual systems can be integrated into accurate and coherent data sets that allow for the development of unbiased, homogeneous long-term trends.

Automation will enable growth at reduced costs by allowing for increases in data frequency and consistency while avoiding coincident increases in labour costs. Further development of integrated surface-based remote sensing systems will make it possible to provide observations of key atmospheric variables and processes relevant to weather, water and climate with high time resolution.

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.

Network Design will be addressed through a coordinated effort of NMHSs and other data providers to minimize duplication and by optimization of the observing network design and its flexibility to incorporate new observing systems after their successful testing and evaluation.

5 WIGOS CONCEPT

5.1 Objectives and scope

Nowadays, rapid assessments of the current state of the Earth system and timely detection and prediction of changes in it are required by WMO stakeholders and its partners. The establishment of an integrated operational observing system that routinely, reliably and continuously provides the information required, is essential if this is to be achieved.

Objectives

The Fifteenth World Meteorological Congress envisaged that WIGOS should encompass four broad objectives:

(a) Improving management and governance (use of resources, planning, institutional and programme structures, and monitoring);

(b) Increasing interoperability between the various systems with particular attention given to the complementarity between the space-based and *in-situ* components of the systems;

(c) Addressing the domains (atmospheric, oceanic and terrestrial, including hydrological) as a comprehensive total system;

(d) Ensuring that broader governance frameworks (e.g. inter-agency co-sponsorship of systems) and relationships with other international initiatives (e.g. GEO) are respected, sustained and strengthened.

Scope

In meeting the above objectives, WIGOS will serve WMO Members and partners and will also make a major and unique contribution to United Nations agencies that are focused on environmental stewardship, and along with WIS, will be a core contribution of WMO to GEOSS.

To achieve these objectives, which were demonstrated in the Test of Concept phase, the scope of WIGOS will encompass the following:

- *Requirements:* Provide a mechanism to meet new observational requirements of WMO Members and WMO partner organizations building on the existing Rolling Review of Requirements (RRR) process;
- *Integration:* Build upon and add value to the existing WMO observing components of GOS, GAW, and WHYCOS with emphasis on integration of surface- and space-based observations;
- *Standardization:* Enhance observational data quality and homogeneity by introducing improved data quality and data management standards to better satisfy user requirements;
- *Access:* Improve access to, and utilization of, observations and products from WMO observing systems as well as those of co-sponsored systems;
- *Coordination:* Foster research and development activities and coherent planning for future observing systems and network optimization by working with all WMO Programmes and partner organizations.

5.2 Key elements of the operational WIGOS

Following the guidance by Cg-XV, WIGOS will build on and add value to WMO's existing observing systems by coordinating their efforts, addressing shortcomings, supporting their interoperability, while meeting user requirements.

The list of current observing networks as the key elements of the future operational WIGOS is given in Chapter 3. Integration, as a prerequisite to WIGOS implementation is described in Section 1.3.4. Congress also identified that the progress with the WMO Information System (WIS) will be essential element for the WIGOS framework. The WIGOS standardization process and quality management procedures will ensure that user requirements for various application areas are met at national, regional and global levels.

5.2.1 Integration, Standardization and Interoperability

It is envisioned that the integration process will bring about architectural and governance structures as well as processes for WIGOS development, implementation and sustainability. Standardization and interoperability, including data compatibility, are primary factors enabling integration.

Key areas of standardization

A key requirement for success is the standardization in three areas as shown schematically in Figure 1:

- Instruments and methods of observation;
- WIS information exchange and discovery;
- Quality management framework.

5.2.2 Standardization of instruments and methods of observation

WIGOS should encompass homogeneity, interoperability, compatibility and traceability of observations from all WIGOS constituent observing systems. This should be based on guidance and studies and achieved through implementation of recommendations on methods of observation by the Instrument and Methods of Observation Programme (IMOP) and related programmes of partner organizations within WIGOS constituent networks, including tests, calibration and intercomparisons.

5.2.3 WIS Information exchange and discovery

In order for WIGOS to effectively and efficiently respond to user data needs, WIGOS will use the WMO Information System (WIS) as a data exchange, discovery, access, and retrieval mechanism. Observational data and products generated by all WIGOS constituent networks, as well as associated metadata, shall meet a comprehensive, standardized set of WIS data and metadata exchange requirements.

Technologically, the key action leading to the desired integrated networks will be the generation of data and information from WIGOS constituent networks using comprehensive, standardized data representation. More specifically, the role of WIS will be as follows:

- It will be used in the collection and sharing of information for all WMO and related international programmes;
- It will provide a flexible and extensible structure that will allow participating centres to enhance their capabilities as their national and international responsibilities grow;
- It will provide communication networks based on communication links used within the World Weather Watch (WWW) for distribution of high priority real-time data;
- It will utilize international agreed-upon standards for protocols, hardware and software.

Detailed description of WIS is presented in the WIS Project and Implementation Plan (Section 2.3).

5.2.4 Quality Management Framework

The third key area of standardization for WIGOS should embrace a quality management framework (QMF) and the development, use and maintenance of the relevant WMO technical regulations to ensure that:

- observations, records and reports on weather, water, climate and the natural environment are of documented quality for international exchange through the WMO coordinated systems and relevant joint standards with other international organizations,
- the best possible products and services are delivered to end users. This should be based on agreed-upon quality assurance and quality control standards, with the goals of developing and implementing an integrated quality management system that delivers reliable and timely data streams with adequate quality control and relevant metadata.

The corresponding activities shall be compliant with Resolution 31 (Cg-XV), Implementation of Quality Management Systems by National Meteorological and Hydrological Services and Resolution 32 (Cg-XV), WMO Quality Management Framework.

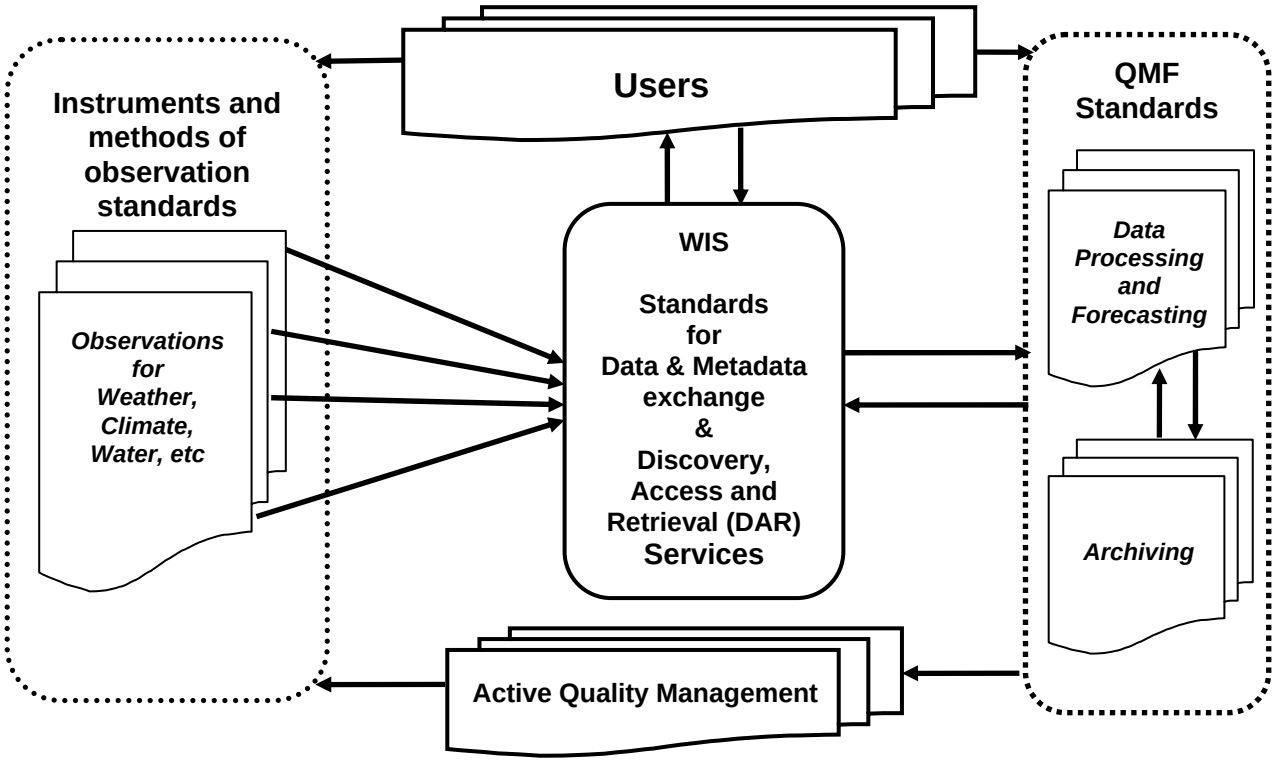

Figure 1: Key areas of WIGOS standardization

5.2.5 Rolling Review of Requirements (RRR) process and evolution of observing systems

To ensure continuous review of the requirements placed on the current observing systems and to have the capability to effectively adjust and respond to evolving needs, WIGOS will be using the RRR process defined by the Manual on the Global Observing System (WMO-No. 544). In the RRR process schematically shown in Figure 2, user requirements for observations are compared with the capabilities of present and planned surface-and space-based observing systems to objectively indicate the feasibility of achieving the stated requirements for a given Application area (see Section 3.2). The resulting Statements of Guidance (SOG) provide an assessment of the adequacy of the observations to fulfil requirements and suggests areas of progress towards improved observing systems. Within the WIGOS framework the most significant variables for each Application area will continue to be analyzed in the SOGs. Both user requirements and observing system capabilities are collated in a comprehensive, systematic and quantitative way in the WMO/CEOS database, which is accessible at: http://www.wmo.int/pages/prog/sat/Databases.html.

Using the above RRR process defined by the Manual on the Global Observing System (WMO-No. 544) (Part II, Requirements for observational data), user requirements for observations are compared with the capabilities of present and planned observing systems to provide them. Both user requirements and observing system capabilities are collated in a comprehensive, systematic and quantitative way in the WMO database, which attempts to capture observational requirements to meet the needs of all WMO programmes. The comparison of user requirements with observing system capabilities for a given application area is called a *Critical Review*. The output of the Critical Review process is reviewed by experts in the relevant application and used to prepare SOG, the main aim of which is to draw attention to the most important gaps between user requirements and observing system capabilities, in the context of the application. A wide range of applications within WMO programmes have already been addressed. Further information is available at: http://www.wmo.int/pages/prog/sat/Databases.html.

As directed by Congress, it is essential to implement the RRR Process to ensure that WIGOS will address and meet stakeholders' needs. Therefore, it is also essential that user requirements are kept continuously under review.

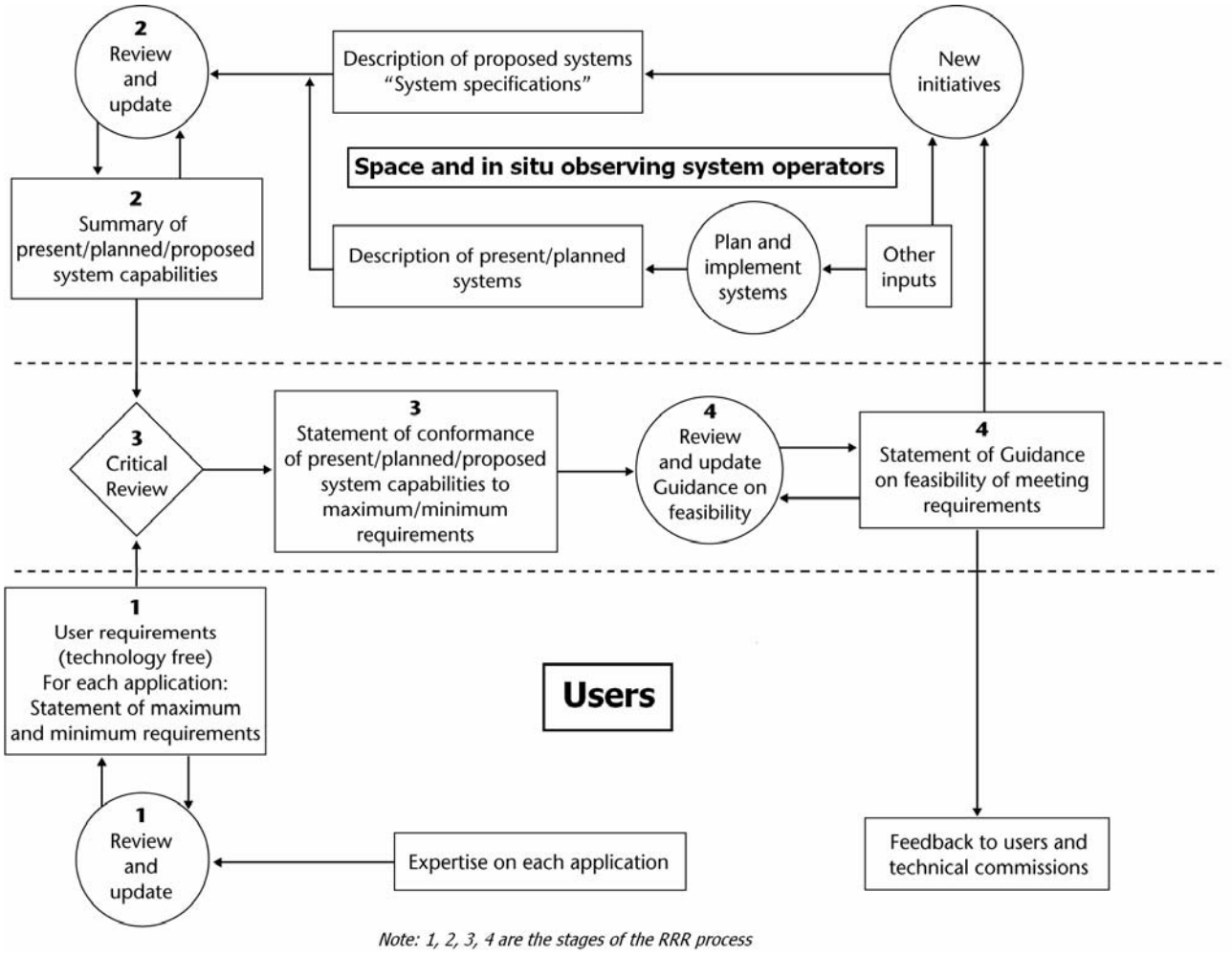

Figure 2: Rolling Review of Requirements Process

5.2.6 Operational Database

A distributed database (DB) describing all the observing systems components and respective networks contributing to WIGOS should be developed to provide end users with relevant metadata, crucial for the operation of WIGOS and for the WIS Data Discovery, Access and Retrieval (DAR) services. A database should allow users to make relevant recommendations in terms of network design, evaluation and optimization; system governance and management and all other aspects dealing with observing system operation and performance.

For the purposes of developing such a database, data producers will be fully responsible for providing adequate and sufficiently detailed metadata related to all parts of their observing systems and networks. Generally, the WIGOS operational database should include the following:

- Basic observing network/system characteristics (governance, management, observing programme, standard compliance information, data policy, etc.);
- Basic station characteristics (name, number/identifier, geographical coordinates, observing programme, etc.);
- Basic instrument characteristics (siting, exposure, sensor type, principle of operation, instrument performance); data-processing, handling, transmission, quality assurance information, etc.).

5.2.7 Standardization Database

A database of standards should be developed. It would provide a single access point to all the WMO standards, guidelines, best practices, procedures, etc., addressing all aspects of observations (instruments, methods of observation, metadata format, coding, etc.).

Such a database would enable, on one hand, the network managers and operators to easily access the information they need to set-up and run their systems and, on the other hand, the data users to understand the standards that were used in performing specific observations they are considering to use providing appropriate metadata are available.

5.2.8 Roles and Responsibilities

Coordination of WIGOS constituent systems will require long-term commitments from all participants and mutual understanding by all partners to accomplish their current and planned observational activities in a coordinated manner. In order to move towards full WIGOS operations, the entities listed below are considered to have essential roles and should assume, along with their general terms of reference, the following responsibilities:

WMO Members:

- Design, develop and implement national observing systems according to the Vision for global observing systems in 2025; GAW Strategic Plan (2008-2015); WHYCOS guidelines; GCOS, GOOS and GTOS Implementation Plans;
- Implement standards in accordance with WIGOS regulatory material;
- Participate in national, regional and international cooperation mechanisms;
- Provide adequate resources for WMO Secretariat support for WIGOS implementation, either through regular WMO budgetary process, or in kind, via secondments and/or through contributions to the Trust Fund.

Executive Council:

- Steer and monitor WIGOS development and implementation activities, and achieve the broadest possible collaboration, cooperation and coordination of all stakeholders;
- Coordinate WIGOS and WIS implementation plans and activities;
- Provide advice, guidance and support for the implementation of WIGOS.

Regional Associations:

- Develop and coordinate Regional WIGOS and WIS Implementation Plans,
- Incorporate WIGOS and WIS in their operating plans and work programmes;
- Identify priority areas where observational requirements can be met more effectively through integration of surface-based and space-based subsystems;
- Determine regional priorities for observing system development and provide input for regional observing system needs into the RRR Process;

- Provide advice and feedback to Members on WIGOS related activities;
- Encourage proactive involvement of Members in regional WIGOS and WIS implementation activities.

Technical Commissions:

- Develop guidance for the design and evolution of observing systems utilizing the RRR Process;
- Develop WIGOS standards, including metadata standards, in collaboration with partners;
- Provide technical guidance and advice to Members and Regional Associations on WIGOS;
- Review, update and harmonize WMO Regulatory Material;
- Coordinate WIGOS and WIS implementation;
- Integrate WIGOS activities within work programmes of relevant groups and/or expert teams;
- Provide the technical lead for WIGOS through Commission for Basic Systems (CBS) and Commission for Instruments and Methods of Observation (CIMO).

WMO Secretariat:

- Ensure management of, and support to, the WIGOS implementation process;
- Establish a WIGOS Project Office;
- Develop proposals for programmatic and governance structures in support of WIGOS taking into account WMO's strategic directions;
- Support WIGOS and WIS implementation;
- Ensure proper coordination with other observing systems contributing to the GFCS as it develops;
- Coordinate and collaborate with partner organizations and programmes in WIGOS activities;
- Support regional associations and technical commissions in developing their WIGOS implementation strategies and projects, including outreach and capacity-building activities;
- Work with Members and donors to provide adequate resources for WIGOS implementation.

Partner Organizations:

- Collaborate with WMO in establishing appropriate coordination mechanisms;
- Coordinate with WMO to create and maintain interoperability among observing systems;
- Coordinate with WMO on data policy.

5.2.9 Governance

WIGOS will enable a common standardization approach, uniform implementation of WMO regulations, and data integration and interoperability across all WMO observing systems. It will also provide a single focus for integrated and coordinated operational management of all WMO observing systems and a mechanism for coordination with WMO co-sponsored and contributing observing systems.

Therefore, in implementing WIGOS it is imperative that the current management, governance and support activities be reviewed and aligned with WMO strategic planning and results-based management. This alignment should enable collaboration and promote cooperation and coordination at the technical, operational and administrative levels.

Central coordination through the WMO Secretariat is essential for successful WIGOS implementation. In addition, the long-term commitment and effort of WMO Members; greater international cooperation; and sustained technological, capacity building, and financial support for developing and least developed countries is important.

The development of an effective and efficient system of governance will require adequate scientific and technical advisory mechanisms to develop, monitor, and evaluate the WIGOS implementation

process. The WMO Executive Council, through its EC-WG/WIGOS-WIS, will continue to steer and monitor WIGOS activities to ensure the broadest possible collaboration and cooperation.

Given the significance of active cooperation and enhanced coordination among the technical commissions, regional associations, and WMO partners, appropriate steps will need to be taken to ensure that the integration process is incorporated in the work programmes and implementation plans of these entities. For this purpose, it is highly desirable that an Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) be established. This group would replace the Subgroup on WIGOS and would be expected to:

- Coordinate, review, refine, and assess the development and implementation of WIGOS;
- Provide technical guidance and assistance for the WIGOS development, planning, and implementation activities, such as standardization and development of WIGOS databases;
- Advise regional associations on WIGOS implementation activities;
- Advise technical commissions on the standardization process and related activities;
- Coordinate cooperation at a technical level with WMO partner organizations, including UNESCO and its IOC, UNEP, FAO, and ICSU;
- Address major issues identified by EC-WG/WIGOS-WIS;
- Advise EC-WG/WIGOS-WIS on further development and implementation of WIGOS; and
- Report to EC-WG/WIGOS-WIS.

Furthermore, for WIGOS to be successful, it will be necessary to identify terms of reference for task teams at the regional and commission levels and, when appropriate, with representatives of partner organizations. Major tasks should be assigned as follows:

- Regional task teams will need to coordinate planning and implementation of WIGOS on the regional level with WIS implementation and, eventually, with the implementation of GFCS in order to optimize regional and national observing systems;
- Inter-Commission Task Teams, which should include representatives of partner organizations, will need to address standardization, observing system interoperability, data compatibility, data management, Quality Management System (QMS) procedures, performance monitoring, WMO regulatory material issues, and proposed improvements in observing networks/systems.

Improving coordination will be an ongoing activity at policy, technical, and Secretariat levels. This will need to be supported by a high-level reconciliation mechanism defined in the WMO-UNESCO-IOC-UNEP-FAO-ICSU Memoranda of Understanding (MOU) in order to resolve possible problems in data policy, product delivery, and other governance issues.

These interagency and inter-observing system coordination mechanisms will need to be complemented and supported through similar cooperation and coordination arrangements among NMHSs and through national implementation mechanisms for GCOS, GOOS, GTOS, and GEOSS.

5.2.10 Resources

Members provide substantial resources to sustain and improve their observing systems. During the implementation phase, WIGOS operational activities may require additional resources and support at the national, regional and global levels as well as within the WMO secretariat. They may also require additional resources within observational programmes of WMO partner organizations. However, implementation of WIGOS will provide efficiencies and increased effectiveness in meeting observing requirements.

It is recognized that WIGOS operations will be carried out in accordance with the principle that these activities are within the responsibility of the Members themselves and should be borne by national resources (see section 3.2). Therefore, most of the resources will be provided through existing national and international mechanisms, and by voluntary contributions to special WIGOS projects.

5.3 Principles and Assumptions

The proposed WIGOS concept relies on a set of principles and assumptions that are derived from WMO operational policies or are inherent in an environment of co-sponsored systems.

The following principles should be taken into account:

- WIGOS development and implementation will cause no harm or limitation to the existing WMO or co-sponsored observing systems;
- Different levels of development as well as diversity of Member's capabilities, needs and available resources will have to be taken into account;
- Acquisition of additional funding and resources will require continuous efforts on national and international levels.

The implementation of WIGOS assumes that:

- The WIGOS integration process will be a complex, evolving and challenging undertaking; it will require significant support of WMO Members to be successful.
- 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.
- The continuing sense of ownership by the various groups that have initiated and developed the individual observing system components through directly involving these groups in the planning and implementation of the WIGOS will be guaranteed.
- Significant technical innovation and capacity-building activities will be essential to take advantage of WIGOS benefits, especially in the case of developing countries and LDCs.

6 OPERATIONAL POLICY CONSIDERATIONS

Many of the building blocks (see Section 5.2) of the future operation of WIGOS already exist and are of high value to current users. It is recognized that proper interaction between constituent systems of WIGOS with respect to data management and standardization necessitate an unprecedented level of coordination and collaboration among the owners of the observing systems.

6.1 Data policy

WIGOS will respect the data policies of partner organizations and will adhere to the decisions of the Twelfth and Thirteenth World Meteorological Congresses (1995, 1999) that adopted Resolution 40 (Cg-XII) "WMO Policy and Practice for the Exchange of Meteorological and Related Data and Products including Guidelines on Relationships in Commercial Meteorological Activities" and Resolution 25 (Cg-XIII) "Exchange of Hydrological Data and Products" respectively.

WIGOS will strive to ensure that the conditions placed by the originator on the additional data and products are respected and made known to initial and subsequent recipients for the exchange of meteorological and related data and products, including guidelines on relationships in commercial meteorological and hydrological activities.

Since there are differences among existing policies of partner organizations, it may not be possible to integrate them into one single Data Policy. In this connection WIGOS Data Policy should be preferably composed of two main parts, the first defining common policies and the second specifying individual data sharing principles and practices of all WIGOS partners.

Common WIGOS Data Policies

- The common policies could be seen as a minimum set of commonly agreed principles, adopted by consensus of all partners. In this way WIGOS partners would retain their full autonomy.
- Major commonality of WIGOS partners' data policies relate to the provision of data (and

metadata) for non-profit, scientific and/or educational purposes. Special consideration to research and education could be described in this part of WIGOS Data Policies.

- Many partners' data policies also refer to the full and open access (exchange) of data and metadata with minimum time delay, free of charge or at the cost of no more than the cost of reproduction and delivery. There may be, however, partners that do not fully recognize these principles but may be willing to reconsider and expand their current policies and these would require appropriate level of negotiation.

Individual data sharing principles and practices

- It would be inappropriate to enforce or otherwise make mandatory any policy by WIGOS to its partners. The participation in WIGOS is voluntary. Some partners have generic policies while others have quite complex policies and practices. All partners taking part in WIGOS should do all they can to improve availability and delivery of their observational data and products.

6.2 Relationship with the WMO and co-sponsored observing systems

Effective implementation and operation of WIGOS will require close ongoing collaboration with several of WMO's partner organizations (UNESCO and its IOC, UNEP, FAO, and ICSU) with whom it co-sponsors GOOS, GTOS and the cross-domain GCOS. Collaboration will be necessary in order to ensure essential interoperability and mutual support while also respecting and reinforcing the individual identities and mandates of both the partners and their co-sponsored observing systems. It will also require a clear understanding, at both international and national levels, as to how WIGOS, GCOS, GOOS and GTOS fit together within the overall framework of GEOSS.

By virtue of WMO's co-sponsorship of the IOC-led GOOS and the FAO-led GTOS, those parts of these systems which contribute to, or support, WMO research and service programmes**,** are appropriately regarded as contributions to WIGOS. Every effort should be made, therefore, to achieve full interoperability and mutually supportive advisory and coordination arrangements with both GOOS and GTOS.

Similarly, the jointly-sponsored, cross-cutting GCOS, which is made up primarily of the climate-relevant components of WIGOS, GOOS and GTOS, will need to be implemented and operated on the basis of maximum possible complementarity and mutual support between GCOS and its component systems, including WIGOS.

Improving coordination will be an ongoing activity at policy, technical, and Secretariat levels. This will need to be supported by a high-level reconciliation mechanism defined in the WMO-UNESCO-IOC-UNEP-FAO-ICSU Memoranda of Understanding (MOU) in order to resolve possible problems in data policy, product delivery, and other governance issues. The existing Interagency Coordination and Planning Committee for Earth Observations (ICPC) should be strengthened and used for such coordination activities.

These interagency and inter-observing system coordination mechanisms at the international level will need to be complemented and supported through similar cooperation and coordination arrangements between NMHSs and their counterpart national implementation mechanisms for GCOS, GOOS, GTOS and GEOSS.

6.3 Science Support

New technology and scientific knowledge is required to meet WIGOS user requirements. Both hypothesis-driven and mission-driven research is of fundamental importance to the evolution of WIGOS as a fully integrated system. Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) carried out by leading NWP centres will be key factors to support advances in operational capabilities of WIGOS related to the best mix of observing systems and to give advice to WMO Members on ways forward.

WMO's science experiments, such as THORPEX and AMMA, are providing insights into the value of

targeted observational strategies and observing system considerations which are important to the design and implementation of WIGOS.

7 IMPACTS AND IMPLICATIONS

Congress emphasized that integration in the context of WIGOS would have an impact on the structure and functions of WMO, on international collaboration, cooperation and coordination as well as direct consequences to national programmes and activities. Therefore, awareness of potential impacts would be essential for NMHSs and other national/international agencies operating observing networks to ensure understanding and accepting the WIGOS design and its implementation.

7.1 Impacts on WMO

For the purpose of integration in the context of WIGOS, appropriate organizational, programmatic, procedural, and governance structures will enable a common standardization approach and uniform implementation of WMO regulations and practices. This will ensure data integration and interoperability across all WMO observing systems.

The potential impacts will be considered in details with respect to:

1. WMO Secretariat (WIGOS supporting organizational structure);
2. WMO Programmes (WIGOS supporting programmatic structure);
3. WMO Technical Commissions (WIGOS supporting governance structure); and
4. WMO Technical Regulations (WIGOS supporting procedural structure).

A set of organizational, programmatic, governance and procedural arrangements for sustainability and reliability of the operational observing networks/systems (structure and function improvements) will be implemented successively.

7.2 Operational impacts

Operational impacts will comprise step-by-step implementation resulting in better:

- Standardization, interoperability and data compatibility arrangements in operational observing networks and systems.
- Procedures for improved quality, traceability and consistency of observations (recommendations on instruments and methods of observation);
- Procedures for the generation of observational data, products and associated metadata from WIGOS constituent networks using comprehensive, standardized data and metadata representation in compliance with WIS information exchange requirements for all WMO and co-sponsored Programmes.
- Quality management system and data/metadata management procedures;
- Procedures and processes of performance monitoring, evaluation, feedback and corrective actions.

Potential operational impacts may also include introducing new modes of operation based on emergency, disaster or accident conditions and changes in the operational budget.

Other impacts will include:

- The commitment of additional resources (funding, staff, time) by Members, partner Organizations and the WMO Secretariat to efforts addressing WIGOS development and implementation;
- Adjusting relationships between WMO and co-sponsored observing systems (e.g. changes in MOUs etc.).
- User involvement in extended capacity building activities and technology transfer.

7.3 Challenges

Challenges and needs associated with embarking upon integration of the WMO and co-sponsored observing systems include but are not limited to:

- Active collaboration, improved cooperation and coordination of all partners;
- Firm long-term commitments of all concerned;
- The timely and effective implementation of the integration concept by individual Members;
- Differences in levels of development of national and regional systems and services;
- The need to complete the full functionality of WIS so that WIGOS can exploit new data access and retrieval facilities;
- The importance of engaging the hydrological community in WIGOS activities;
- The need to clarify and communicate the relationship and intersection of WIGOS with the co-sponsored observing systems, (GOOS, GTOS and GCOS) and with GEOSS;
- Finding ways to demonstrate the opportunities of WIGOS to all potential partners and users to build their ongoing support, trust and collaboration;
- Finding a way to more effectively integrate all WMO observing activities and address their different requirements and priorities, especially the need to ensure WIGOS effectively supports all WMO applications programmes;
- Documenting and validating requirements for operational weather, climate, water and related environmental observations (building on Rolling Requirements Review);
- Specifying relevant processes, procedures and relationships;
- Determining standards, procedures, practices and protocols;
- Step-by-step implementation of sets of standardization, interoperability and data compatibility arrangements into operational observing networks and systems;
- Systematic and rigorous performance monitoring and evaluation (PM&E) of WIGOS capabilities; and
- An adequately structured and resourced WMO Secretariat.

7.4 Risks

Cg-XV recognized that the integration process would be a complex undertaking that would be challenging. Risks identified at various stages of the development and implementation of WIGOS are as follows:

- Resources will be a critical risk factor in achieving timely completion of WIGOS goals;
- Effective and constructive cooperation, collaboration and coordination is not achieved;
- Long-term commitments by all partners are not achieved;
- The concept of WIGOS is not properly understood;
- The timeframe for implementation of WIGOS is not achieved;
- Adequate resources and support are not available to all stakeholders to achieve key elements of WIGOS implementation;
- Resource, coordination etc. requirements for ongoing operation of WIGOS are inadequately understood and/or provided for;
- Prompt delivery of WIS is not ensured, and
- Full implementation of agreed-upon standards, procedures and practices is not achieved across all WMO observing systems.

8 LIST OF ACRONYMS

AMDAR	Aircraft Meteorological Data Delay
AMMA	African Monsoon Multidisciplinary Analysis
BSRN	Basic Surface Radiation Network
CBS	WMO Commission for Basic Systems
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CONOPS	Concept of Operations
EC WG	Executive Council Working Group
EUCOS	EUMETNET Composite Observing System
EUMETNET	The network of European National Meteorological Services
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Service
GOOS	Global Ocean Observing System
GOS	Global Observing System
GRUAN	GCOS Reference Upper-Air Network
GTOS	Global Terrestrial Observing System
ICG-WIGOS	Inter-Commission Coordination Group on WIGOS
ICG WIS	Inter-Commission Coordination Group on WIS
ICPC	Interagency Coordination and Planning Committee for Earth Observations
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission
ISO	International Standards Organization
JCOMM	Joint WMO/IOC Commission for Oceanography and Marine Meteorology
MOU	Memorandum of Understanding
NMHS	National Meteorological and Hydrological Service
NWP	Numerical Weather Prediction
OPAG IOS	CBS Open Programme Area Group on the Integrated Observing System
QA	Quality Assurance
QC	Quality Control
QMF	Quality Management Framework
QMS	Quality Management System
R&D	Research and Development
RRR	Rolling Review of Requirements
SOG	Statement of Guidance
TC	Technical Commission
THORPEX	The Observing System Research and Predictability Experiment
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WDIP	WIGOS Development and Implementation Plan
WHYCOS	World Hydrological Cycle Observing System
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WWW	World Weather Watch

Appendix III

WIGOS IMPERATIVE

Since its establishment as a UN Specialized Agency almost 60 years ago, WMO through its Members has advanced the observing and monitoring of the Earth's weather, water and climate systems. This has led to better understanding of the Earth's environmental system and resulted in the delivery of improved and expanded services such as weather, hydrological and air quality forecasts, climate outlooks and expanded advice and services to society. These services extend across timescales from severe weather warnings to weekly forecasts to seasonal climate prediction with broad applications across social and economic sectors world wide.

The challenge drives the need for change: An increasingly complex society and sophisticated user community, reflected by rapid economic and industrial development, coupled with the changing Earth's climate has resulted in greater vulnerability of society to extreme weather events and climate change. This has resulted in the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science based understanding of the Earth and its environment: the end result being better prediction and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

The WMO Integrated Global Observing System (WIGOS), endorsed by the Fifteenth WMO Congress is a major contribution of WMO to this challenge. Indeed, WMO Congress decided that the enhanced integration of the WMO observing system should be pursued as a strategic objective of the WMO and identified this as a major expected result of the WMO strategic plan.

Vision: WMO will establish an integrated, comprehensive and coordinated observing system, WIGOS, to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members and will enhance coordination of WMO observing systems with those of partner organizations for the benefit of society.

WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations. This will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

Scope: WIGOS will

- Build upon the existing observing components of WWW GOS, GAW, and WHYCOS, and will capitalize on existing, new and emerging technologies.
- Improve access to and utilization of surface-based observations and products from co-sponsored systems such as GTOS, GOOS and GCOS through enhanced coordination with partner organizations.
- Improve its space-based component by enhanced collaboration through partnerships such as the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS).
- Enhance integration between its surface- and space-based components.
- Provide a mechanism to meet new observational requirements of its Members.
- Make a major and unique contribution to United Nations agencies that are focused on environmental stewardship and to the GEOSS.

Benefits: improved observing capability in a more cost effective manner to enable improved service delivery because

- WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations: this will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

- WIGOS will better enable WMO Members' to meet expanding national mandates and achieve higher national visibility with other environment related agencies. In doing so, WMO Members will be able to better respond to natural hazards, improve environmental monitoring, and adapt to climate change and man-made environmental impacts. In this regard, WIGOS together with WIS will greatly enhance operational components of WMO Programs, especially in Developing and Least Developed Countries.
- WIGOS will provide a mechanism for enhanced integration between its surface and space based components.
- Integration will lead to efficiencies and cost savings that can be reinvested to overcome known deficiencies and gaps in the observing system. In this way WIGOS will provide capabilities to better utilize existing and emerging observational capabilities.

Imperative: WIGOS is a necessary prerequisite to allow WMO Members to realize the organization's strategic thrusts which are

- Improve service quality and service delivery.
- Advance scientific research and application as well as development and implementation of technology.
- Strengthen capacity building.
- Build and enhance partnerships and cooperation.
- Strengthen good governance.

In the sections that follow, addressed through the WMO Strategic Thrust areas, it will be shown how WMO can build upon existing capabilities and partnerships to bring WIGOS to fruition. It should be noted that integration with its coinciding benefits is not new, and some stellar achievements3 will be included in the text that follows to help place WIGOS in the proper context. By learning from the past, as well as from current precursor activities to WIGOS such as the WIGOS Demonstration and Pilot Projects, we, WMO and its partners can build a more effective, robust, sustainable and cost effective integrated observing system – the WIGOS. But first: one story of successful integration that has positively affected every WMO Member.

An overarching example of success: Across the globe, NMHSs benefit from the output of today's Numerical Weather prediction models. Improvements in model forecast skill have increased dramatically over past decades and today's model forecasts for the southern hemisphere have become as accurate as those from the more data rich northern hemisphere. The key to a good forecast has its basis in observations and their assimilation; and, NWP on time scales from 1 to 14 days requires observations from all parts of the globe. Those observations are provided by a Global Observing System comprised of a variety of in-situ and satellite observations: the system is continually evolving and all of those data are valuable. However, one can unequivocally point to the successful integration of data from sophisticated space-based observations with data from in-situ systems, made possible by advanced data assimilation systems that led to this breakthrough. Why? Satellites do not directly measure geophysical parameters such as temperature and pressure but rather observe radiances. At first when satellite data were used in NWP it was natural to try and make the satellite measurement resemble the geophysical variable that the model was designed to use, vertical profiles of temperature and moisture. This assimilation of satellite data using optimal interpolation schemes of the 1980s resulted in satellite data having little, or even negative impact on NWP forecasts, and in the late 1980s satellite retrievals were blacklisted by many NWP centres. In the 1990s variation analysis schemes were introduced into data assimilation systems by many of the larger NWP centres, and by the end of the 20th Century the direct assimilation of satellite radiances had dramatically raised the importance of satellite data importance to NWP. Advances in NWP and science also played a major role in this breakthrough, but it was the successful integration of satellite with in-situ observations through advanced assimilation that brought success.

Into the future: The way forward with enhanced capability from NWP, from a data integration point of view clearly lies in the area of assimilation. Every few years WMO sponsors a Workshop on the

3 The achievements are by no means all of those that have occurred, they are only meant to serve as example; omission of some by no means reflects priority or contributions of those other activities.

Impacts of Various Observation Systems on NWP. Those workshops are attended by leading experts from the NWP and observations communities and look at impacts from various observing systems through Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) and give advice to WMO Members on ways forward. For example, while satellite data integration has provided for major advances forward in NWP forecast capability challenges remain to improve utilization of those data; those challenges, identified at the Impact Workshops are being addressed in a priority order by NWP centres. Furthermore, results from science experiments such as WMO's THORPEX and AMMA are providing insights into the value of targeted observational strategies and observing system considerations which are important to the evolution of the WIGOS. In the future, as we improve in seasonal-to-interannual forecasts, integration of information from oceans and land will take on ever increasing importance, as pointed out in the WMO statement of guidance for seasonal-to-interannual forecasting "The time and space scales associated with seasonal-to-interannual variability suggest the key information for forecasts will derive mostly from the slow parts of the climate system, in particular the ocean, but also the land surface. When considering impacts such as rainfall deficiencies or increased temperatures over land, however, there are very good reasons for considering variables associated with the land surface conditions. In particular, land surface moisture and vegetation should be specified and predicted. The models should also include up-to-date radiative forcing (e.g., greenhouse forcing), which are important for maximizing skill in forecasts of land-surface air temperature anomalies relative to recent historical reference-normal periods." Clearly the demands of climate modelling require an integrated and comprehensive environmental observing system that can only be provided by WMO and its partners.

STRATEGIC THRUST: Improve Service Quality and Service Delivery

Our common goal:

1. Enhanced capabilities of Members to deliver and improve access to high quality weather, climate and water and related environmental predictions, information and services in response to users' needs and to enable their use in decision-making by all relevant societal sectors
2. Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate and water and related environmental elements

***Example of success*:** Severe Weather Forecasting Demonstration Project. While NMHSs in more advanced countries have benefited from the integration observations through advanced assimilation into NWP, developing and least developed countries have lagged behind. Recognizing the benefits of integration and the resultant products in improving forecasting capabilities, in 2006 WMO initiated the Severe Weather Forecast Demonstration Project (SWFDP) in six South African countries that were highly impacted by Indian Ocean tropical cyclones. This highly successful project encompassed specialized training. It was underpinned by the Global Data-Processing and Forecasting System through improved access to, and effective use of outputs of numerical weather prediction products from advanced NWP centres, and was undertaken in collaboration with the Public Weather Services to improve the delivery of warning services. Tangible results included more reliable warnings and improved relationships between NMHSs and disaster managers and the media. In the context of the SWFDP, EC-LXI noted "… that in the SWFDP in southern Africa, in addition to the expansion into all sixteen countries of the region, RSMC Pretoria intended to extend its regional guidance role to include marine forecasting and to consider future incorporation of additional aspects, such as for aviation and flood forecasting, and a Web-based system for exchange and display of warnings in the region."

Into the future: The first regional project, which started in 2006, is being expanded to include all 16 countries of southern Africa and will span all seasons. One next step is to identify gaps in the observing system to improve verification of the warnings. A second project is in its early stage of implementation for the South Pacific Islands will address heavy rains, strong winds and damaging waves. No doubt others will follow along similar lines in other regions. It should be expected that in the future similar projects will extend across the major WMO applications areas served by the CBS's Rolling Review of Requirements: Climate Monitoring; Global NWP, Regional NWP, Synoptic Meteorology, Nowcasting and Very Short Range Forecasting, Seasonal to Inter-annual Forecasts, Aeronautical Meteorology, Atmospheric Chemistry, Ocean Applications, Agricultural Meteorology and Hydrology. Indeed, the Rolling Review of Requirements process, when viewed in the context of the

WIGOS and coupled with information gathered through the WIGOS Demonstration and Pilot Projects, will help identify gaps in the WIGOS. Those gaps can then be filled in a cost effective manner, assimilated and provided to WMO Members to further improve services. It is also clear that common demands across the applications areas require an integrated and comprehensive environmental observing system that can only be provided by WMO and its partners. For WMO Members, WIGOS is the foundation of an end-to-end process that begins in observing and continues through service delivery.

STRATEGIC THRUST: Advance Scientific Research and Application As Well As Development and Implementation of Technology

***Our common goal*:**

1. Enhanced capabilities of NMHSs to produce better weather, climate, and water and related environmental information, predictions and warnings to support in particular climate impact and adaptation strategies.
2. Enhanced capabilities of Members to access, develop, implement and use integrated and inter-operable Earth- and space-based systems for weather, climate and hydrological observations, based on world standards set by WMO, as well as related environmental observations.
3. Enhanced capabilities of Members to contribute to and draw benefits from the global research capacity for weather, climate, water and environment science and technology development

Most of the realization of WIGOS will come through this particular strategic thrust and can be viewed as three levels of integration: a) Standardization of instruments and methods of observation; B) WIS information infrastructure; and, C) End-product quality assurance.

Examples of success: the following examples will be considered: 1) instrument level; 2) observing system optimization; 3) satellites as an integrated system; and, 4) atmospheric chemistry.

Advances in instrumentation: Bringing a level of standardization in instrumentation is a major WMO accomplishment that has fostered integration at a number of levels. It would be difficult to imagine a network for meteorological and hydrological purposes that did not strive to meet the WMO guidelines for platform and instrument specifications, siting, measurement techniques and quality assurance and management of observing systems. Technological advancements have led to improvements in sensor and system capability to withstand severe climate and environmental conditions and to improvements in sensor capability to accurately measure the whole range of meteorological, climatological, hydrological and environmental variables with high precision and reproducibility. These factors significantly improved reliability and availability of observations. These all resulted in more sustainable and robust WMO observing systems providing data in all weather, climate and environmental conditions according to all users' requirements. Over the past 25 years, advances in micro-processing and communications technology, coupled with advances in instrumentation and standardization have made it possible to automate many measurements and remotely control acquisition systems, thus introducing cost-effectiveness into the GOS. Today AWSs are located in remote locations to fill gaps in the surface based observing system. While significant improvements have been realized much remains to be done.

Into the future: Five areas need to be addressed: standardization, automation, testing, networking and assimilation. The first key area to be addressed is standardization of best practices including quality control, metadata and data formats for new and emerging technologies. Standardization is required for all data so that the measurements from individual systems can be integrated into accurate and coherent data sets that allow for the development of unbiased long term trends. Automation will enable growth at reduced costs by allowing for increases in data frequency and consistency while avoiding coincident increases in labour costs. Further development of integrated ground-based remote sensing systems will provide key atmospheric variables such as clouds, winds, temperature and humidity. These systems will observe at high time resolution providing observations of atmospheric processes relevant to climate and weather. Long term testing at instrument "testbeds" will be used to judge their design, effectiveness and cost-efficiency for a full integration into WIGOS. Development in data assimilation techniques will allow the observations to be fully exploited in numerical models in an integrated manner. Assimilation will provide the means for data to be

combined with other data in a cohesive and scientific way, as in NWP, that will allow data to be exploited as part of an integrated observing system where mutual benefits are derived from complimentary data.

Cost effective composite networks: Imagine an evolving optimized observing network within a region which results in a shared work load for the participating NMHSs along with enhanced capabilities and a fair cost allocation. Actually, one needs look no further than the EUCOS (EUMETNET Composite Observing System) Programme which is responsible for the evolution of the terrestrial component of the European observing system required to improve regional numerical weather prediction in the 24 to 72 hour period. EUCOS helped eliminate duplications of effort in the upper air and surface observing components operated by NMHSs, with a Quality Monitoring Portal built to ensure that the quality of all data delivered by the EUCOS networks was maintained at a high level. The EUCOS Operational Programme has brought significantly enhanced capability to the European NMHSs which they would not have been able to deliver on an individual uncoordinated national basis. Those tangible benefits are:

- Delivering more observations over the Ocean, optimized aircraft measurements over Europe and new data from European wind profiler systems and Weather Radar wind profiles;
- Delivering a centralized quality monitoring service with increased network performance and improved efficiency and cost-effectiveness through the centralized QM service allowing EUCOS Members to reduce their national quality monitoring efforts.

Over the oceans, EUCOS, through the E-SURFMAR buoy program has worked to optimize their buoy observation program by re-evaluating observational needs through integration with the space-based observations. The E-SURFMAR buoy program is coordinated with WMO and IOC via JCOMM and the Data Buoy Cooperation Panel. E-SURFMAR provides the link to GOOS and EURO-GOOS, where the network design activities are coordinated. It was recognized that while the requirements for high quality winds for Regional NWP could be provided by the space segment the same was not true for air pressure: thus the decision was made to rely on the space segment for sea surface winds and deploy drifting buoys with only air pressure and sea surface temperature measuring capabilities. At the beginning of the project in 2003 there were 52 buoys with an annual system cost of around 474,000 €/year, in 2010 there will be 110 drifting buoys with a cost of 366,000 €/year: increased observing capability and decreased costs through integration. The reasons for the decreased cost: 1) unit cost for the buoy drifter became cheaper as no more buoys with wind measurement capabilities were deployed; and, 2) associated with this was a significant reduction in communications costs.

Into the future: the development of cooperative networks within Regions and with WMO and its partners. Activities with respect to WIGOS will have commonality in certain regards across WMO, however, it must be recognized that users, requirements, capabilities and services vary from WMO Region to Region as well as within Regions. To move WIGOS forward in a cost efficient manner will require Regional WIGOS Implementation Strategies as well as strategies of how Members within Regions can most effectively work together. At the Regional level, cooperation programs like EUCOS which allow for the testing of new observing strategies and ways toward optimization should be developed. Further, the lessons learnt from the ocean buoy program is one of great importance, where WMO and IOC Members worked together to coordinate a more robust and cost effective observing system. While integration of more conventional networks and observing systems is underway in developed and some developing countries this is not the case across all WMO. In some developing and least developed countries observing capabilities have diminished over time. This must be addressed as part of the WIGOS strategy.

Satellites as an integrated system: From a meagre start almost 50 years ago when satellite images were uncalibrated photographs of clouds and the earth, *growth in remote sensing technology and computer capabilities* have led to the high resolution, multi-spectral digital renderings that satellite data are today. From both polar and geostationary orbits, meteorological and oceanographic satellites are now used by WMO Members for a variety of applications that span scales from nowcasting to climate, and include land, ocean, atmosphere and ecological applications. Simultaneously, new instruments on research satellites have provided insights into future satellite systems while selected data from those

instruments are used on a routine basis for operational purposes by WMO Members. For example, historically winds over oceans, sea level altimetry and ocean colour (health) have been in the remit of research satellites and have been provided in a transparent manner to WMO. Indeed, hyperspectral sounding data from the research Atmospheric InfraRed Spectrometer (AIRS) was the first of its type to be used in operational NWP. Meteorological satellites providing essential data for weather forecasting to NMHSs' across the globe; indeed it would be difficult to find an area of operational meteorology that has not been positively affected by meteorological satellites.

Into the future: The next two decades present exceptional challenges for WMO Members with respect to satellites, their data and exploitation of that data. Over the next ten years, Members will experience a transformation in space-based observing that is massive and unparalleled. Research satellite data will become available to WMO Members at a time when every operational space system of the past decades is undergoing major upgrades: data volumes are about to increase dramatically. This will offer unprecedented opportunities for the development of variety of sophisticated products and services. As capabilities of data and product providers evolve individual Members receiving all the data and products all the time makes no sense: that would constrain a delivery system while stressing a user's ability to cope with information overload. Availability of data and products must be based on the user's requirements. As we take advantage of the future's promise, marked changes will occur in the ways we approach data handling, science, product development, training and utilization. To prepare for the daunting task of monitoring and understanding the earth-atmosphere system from these new data, and ensuring their full utilization, we must work together in global science and operational partnerships.

Atmospheric Chemistry: Aerosols, ozone and longer-lived greenhouse gases are well recognized as "essential climate variables." The importance of including the effects of these atmospheric constituents in model projections and analyses of future climate change on time scales of decadal to century is now well recognized by the science community. The WMO GAW coordinates the Integrated Global Greenhouse Gas Observing System as part of the Integrated Carbon Observing System. Since 1975 WMO has promoted the systematic and reliable observations of greenhouse gases on a global scale by establishing the world reference standard and ensuring the observations and their attendant meta-data are traceable and meet data quality objectives. Requirements are updated biennially using the rolling review process. The data on the mixing ratios of greenhouse and related reactive gases in the atmosphere and the ocean are collected and distributed by the World Data Centre for Greenhouse Gasses in Japan. These measurements have played a critical role in the work of groups such as IPCC in examining climate change and climate adaptation. The effect of aerosols, because of their role in direct radiative forcing and precipitation formation, must be included in regional and global NWP models. Aerosols are highly variable in time and space in the troposphere, with typical residence times of 3 to 14 days; they cannot be represented by climatological distributions.

Into the future: The demands for accurate data by the climate community will continue during the next decade. In addition, incorporation of aerosols and ozone in next generation operational weather analysis and forecasting systems will place increased demands on those data's real time distribution. With the inclusion of aerosols and chemical variables in these advanced modelling systems we can expect the development of new products and services such as air quality predictions and sand and dust forecasts. Recognizing this impending need, WMO developed a WIGOS pilot project that will improve availability of ozone and Aerosol Optical Depth (AOD) and surface Particulate Matter (PM) observations to the user community via WIS and prepare documentation to help other communities make their observing practices compatible. The data will be used for ingestion into assimilation systems for atmospheric modelling; to support improved forecasts of weather, surface ultraviolet radiation and air quality; and, verification of models. Institution of a Rolling Review of requirements will help determine the need for dissemination on timescales appropriate to the applications. An important activity within this WIGOS pilot project includes supporting training and capacity building as necessary.

STRATEGIC THRUST: Strengthen Capacity Building

Our common goal:

1. Enhanced capabilities of NMHSs, in particular in developing and least developed countries, to

fulfil their mandates.

Examples of success: A recent example of this holistic approach to capacity development was the aid project in Mozambique following the devastating floods in 2000. This project provided infrastructure (radars, AWSs), forecast systems to improve services and training to enable the equipment to be properly used and maintained. The Severe Weather Forecast Demonstration Project (SWFDP) is also an excellent example of what can happen when capacity building is undertaken from an end-to-end approach that begins with observations and their assimilation at DPFSs and ends in user services. Along a different vein (but with some interesting intersections to SWFDP) WMO and its space partners developed the Virtual Laboratory for Satellite Training and Data Utilization (VL) that was designed to enhance Members ability to utilize satellite data and products. The VL is a collaborative effort joining the major operational satellite operators with WMO "centres of excellence," COEs, in satellite meteorology. Those COEs serve as the satellite-focused training resource for WMO Members, and there is now at least one COE serving every official WMO language. Shared resources and training materials coupled with modern communications technology has enabled VL training in every WMO Region to be undertaken as a matter of routine; indeed, several COEs have formed Regional Focus Groups (RFGs) where a COE and the WMO Members it serves enter into routine discussions using real-time satellite data by employing internet for both communications and satellite data and product display. The RFG in Central America is very active, and in one instance where hurricane Wilma was threatening Central America the RFG met four times to provide insight into that storm's strength and rainfall potential – one member of the RFG was particularly concerned about whether or not to advise its water resources department to empty a water storage reservoir: loss of water or potential reservoir breach with flooding and loss of life! As a direct result of information gained from consultation through the RFG the decision was made not to empty a water storage facility: that decision saved millions of gallons of water while not placing the country's citizens in harms way.

Into the future: Capacity building for developing and least developed countries was addressed in the Implementation Plan for the Evolution of the GOS, WMO-TD 1267. Areas focused on in that document are equally important for WIGOS. They address issues including public infrastructure, upgrading and restoring of equipment and capabilities, sustainability, the use of new technologies, and human resources.

The virtual lab will continue to grow and help all WMO Members realize benefits from satellite data. In a similar manner, WMO will encourage other major applications areas (global and regional NWP for example) to develop ways to mimic the success of the VL by major NWP centres sponsoring centres of excellence at WMO Training Centres in different Regions. Essentially this is a small extension of the mechanisms that have been demonstrated in the SWFDP where major NWP centres interacted with a RSMC who then coordinated with Members in their region. This extension would link the NWP centre with the RSMC and the local training provider(s) to take full advantage of the various WMO partnerships.

STRATEGIC THRUST: Build and Enhance Partnerships and Cooperation

Our common goal:

1. New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to increase the value of contributions of WMO within the UN System, relevant international conventions and national strategies.

Examples of success: there are numerous examples of success where WMO has worked with its partners to improve our ability to monitor the Earth's environment. The GCOS climate monitoring principles were developed through coordination between WMO, CEOS, CGMS, IOC, UNEP, ICSU, and international conventions (UNFCCC). The growth in our ability to observe the ocean has increased dramatically over the past 25 years. This growth in the global ocean observing system's growth is due to the joint efforts of its sponsors: WMO, IOC of UNESCO, UNEP and ICSU. The GOOS serves as a platform for international cooperation for sustained observations of the oceans, generation of oceanographic products and services and interaction between research, operational, and user communities. Oceanographic researchers, coastal managers, parties to international conventions,

national meteorological and oceanographic agencies, hydrographic offices, marine and coastal industries, policy makers and the interested general public benefit from the GOOS.

Into the future: In the case of marine observations, parts of the future have been outlined in the WIGOS Pilot Project for Marine Observations, focusing on the integration of **in-situ** and space based ocean observing systems. These will be implemented and sustained by the WMO and IOC Members through JCOOM in order to make appropriate data sets available in real-time and delayed mode to WMO and IOC applications through interoperability arrangements with the WMO Information System. Those data sets will be produced according to agreed upon standards and the quality control procedures documented according Quality Management Standard principles. This integration will enhance the coherence and consistency of the data sets and the availability of relevant instrument/platform metadata. More timely and better quality data will be expected while duplicates will be minimized. Similarly, as well as enhancing marine observations through space based observations, sharing of information from traditionally diverse observing systems will also be essential. This has been demonstrated with the work of the Hydrological community in making their rainfall runoff data available through the Global Runoff Data Centre as a part of WIS. This hydrological information can be used for a number of applications including modelling of salinity and with remote sensing data for improved ocean colour products. Furthermore, other societal areas such as marine biology can access selected observations and products through the WIGOS interoperability layer of WIS.

Example of success: The space-based sub-system of the WMO serves a great range of activities that extend into all areas of environmental monitoring. In the early days of WWW the major space agencies formed the Coordination Group for Geostationary Meteorological Satellites which later dropped “Geostationary” from the title to become today’s CGMS. The primary function of CGMS in its early days was backup in the geostationary orbit, and through that contingency planning activity and good will of the major operators, WMO Members have seen backup instituted on at least three occasions so that coverage from geostationary orbit was not lost over a particular WMO Region. In addition, at the request of WMO through CGMS, EUMETSAT has operated a spare METEOSAT to provide enhanced coverage over the Indian Ocean and NESDIS has operated a spare GOES from 60 West to provide coverage over South America. CGMS, along with WMO, also established three science working groups that deal with winds (atmospheric motion vectors (AMVs)), precipitation and sounding. Through those working groups, quality standards and formats have been instituted for AMVs, multi-satellite and multi-sensor algorithms have been developed for estimating precipitation, and advanced atmospheric sounding derivation packages have been made available for use by WMO Members. It should be noted that all three science working groups both advise and provide assistance at various levels within the WMO through VL and major data assimilation centres. The satellite agencies that comprise CEOS have worked with WMO to investigate various theme areas which include carbon, oceans and others and have defined the concept of a CEOS constellation where satellite and surface-based observation systems address the various CEOS themes.

Into the future: Building partnerships and enhanced cooperation is an activity that must encompass the interests of collaborating partners. In the case of WMO and space agencies enhanced cooperation provided a venue for testing satellite concepts, providing examples of success for space agency data and helping define future needs for the space based portion of the GOS – this will easily be evolved to the WIGOS through existing mechanisms. WMO benefited greatly through enhanced access to satellite data and the advanced products and services that those data made available. With JCOMM similar mutual benefits helped forge a positive relationship. Mutual benefits such as this point to ways for WMO to strengthen its interaction with its co-sponsored observing system partners to provide a cohesive environmental data interface for United Nations Agencies that are focused on environmental stewardship as well as GEOSS. Integration of networks across different disciplines will become a necessary bridge for WMO and future partners to cross if we are to meet the grand challenge of Climate Services – Climate Services will require enhanced integration of observations as is pointed out in the GFCS. The potentially devastating impacts of climate change alone and the complexity of that issue justify the need for a coherent WIGOS.

Strategic Thrust: Strengthen Good Governance

Our common goal:
1. An effective and efficient Organization

WIGOS will consolidate the responsibilities of WMO observing systems. However, it should be well recognized and understood that WIGOS is not a consolidation of the responsibilities of WMO partner observing systems, but rather a framework for recognition and agreement of WMO and its partners concerning each observing system's contributions and responsibilities.

Examples of success: Within the WIGOS framework, governance will occur at a number of levels. For example, within the EUCOS governance is established in a regional manner through agreements between Members participating in the program, and as was mentioned previously, the E-SURFMAR buoy program is coordinated with WMO and IOC via JCOMM and the Data Buoy Cooperation Panel which gives the link to GOOS and EURO-GOOS.

Into the future: Integration as a complex undertaking, which will comprise policy as well as technical issues, stretch over several years, and will require the full support of all Members to be successful. The integration will actively involve and eventually depend on the consensus inputs from the technical commissions, regional associations and the Steering Committees of the Global Climate Observing System, Global Ocean Observing System, Global Terrestrial Observing System and the Joint Scientific Committee of the World Climate Research Programme. It would require the approval of the Executive Council, and eventually of Congress, for major phases.

Within WMO: The development of an effective and efficient system of governance to guide and implement WIGOS will require arrangements for effective scientific and technical advisory mechanisms to develop, monitor and evaluate it, and an appropriate WMO Programme and WMO Secretariat structure to support it. To develop a truly integrated WMO global observing system adjustments will need to be made in WMO Technical Regulations and will likely be required in the WMO Programme structure, the working structure and function of the Technical Commission, and of the WMO Secretariat.

Partners and data policy: In progressing toward enhanced integration of, and interoperability amongst WMO observing systems, it will be especially important that this be carried out in close consultation with WMO's partner organizations that co-sponsor some of those systems. This will apply particularly to:

- the joint WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS);
- the WMO contribution to the joint IOC-UNEP-WMO-ICSU Global Ocean Observing System (GOOS); and
- those terrestrial/hydrological observing systems which serve as part of the FAO-UNEP-WMO-ICSU Global Terrestrial Observing System (GTOS).

The ownership and data-sharing policies of all observing components and partner organizations must be respected and ensured; however, it is important that WMO and its partners review their respective data policies with regard to the impending urgencies brought forward by climate change and climate monitoring; the potential for new and improved services to society offered through enlightened data sharing policies and agreements; and, the danger of lost opportunities to better serve society and policy makers when data are not available on a timeframe compatible with need.

_____

Appendix IV

WIGOS TEST OF CONCEPT DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP)

(Version updated by EC-WG/WIGOS-WIS-3, March 2010)

I. Introduction

The following document is an update of the WIGOS Development and Implementation Plan as mandated by the Fifteenth WMO Congress (Cg-XV).

II. Strategic Roadmap for Testing the WIGOS concept

2.1 Cg-XV agreed that planning and implementation of the WIGOS test of concept should proceed in phases defined by the annual sessions of the WMO Executive Council in order to assure oversight, review and direction. To that end, Cg-XV requested EC-LIX to appoint a Working Group to oversee WIGOS and WIS. The process foreseen was one where planning and implementation of WIGOS would be considered at Cg-XVI (2011), and the WIGOS Implementation Plan for the next intersessional period would be determined.

2.2 EC-LIX, by its Resolution 3 (EC-LIX), established the EC Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS) with terms of reference as follows:

(1) Provide advice and guidance in the preparation of an overarching WIGOS Development and Implementation Plan;

(2) Refine the WIS Development and Implementation Plan and ensure coordination between WIGOS and WIS Plans to allow for an integrated WMO end-to-end system of systems;

(3) Monitor the development and implementation of WIGOS and WIS through a “rolling review” mechanism; and

(4) Monitor the development and implementation of WIGOS-WIS “Pilot Projects”, as suggested by the Fifteenth Congress, to test concepts, identify problem areas, and to help in elaborating the Development and Implementation Plan.

2.3 As authorized by EC-LIX, EC-WG/WIGOS-WIS established its Subgroup on WIGOS with following terms of reference:

(1) To provide overall technical guidance, assistance and support for the implementation of the WIGOS concept based on strategic directive of the Fifteenth WMO Congress;

(2) To elaborate in detail the three areas of integration of WIGOS including standard practices to be applied to the different areas of WIGOS integration; integration areas being as follows and further described in the WIGOS Concept of Operations:

- Standardization of instruments and methods of observation (instruments and methods of observation levels),
- Common information infrastructure (WIS data levels),
- End-product quality assurance (QM/QA/QC product levels);

(3) To work with each WIGOS component, propose new components and coordinate agreed inter-actions with other partners (e.g. co-sponsored systems, international initiatives’ systems, etc.);

(4) To refine the concept of WIGOS operations, including its basic definitions;

(5) To address major issues identified by the EC Working Group on WIGOS and WIS;

(6) To develop a mechanism for the inclusion of the regional aspects of WIGOS through involvement of the presidents of regional associations;

(7) To coordinate the WIGOS planning phases (including the Pilot Projects) according to the over-arching WIGOS Development and Implementation Plan;

(8) To coordinate WIGOS implementation with the planning and implementation of the WMO Information System (WIS);

(9) To advise the EC Working Group on WIGOS and WIS on aspects related to management, governance and interoperability;

(10) To report to the EC Working Group on WIGOS and WIS.

2.4 The WIGOS Test of Concept Development and Implementation Plan (WDIP), should take into account the WIS Development and Implementation Plan, and will be updated annually during the four-year period 2008-2011. A draft Version 1.0 of this document was reviewed and updated at the first session of the EC-WG/WIGOS-WIS. Subsequent reviews and updates will benefit from experience gained from the various Pilot Projects, Demonstration Projects and inputs from the technical commissions, regional associations and the advisory/steering bodies of WMO co-sponsored programmes. Meetings of EC-WG/WIGOS-WIS will provide oversight and guidance regarding the evolution of the Plan, which subsequently would be considered at each session of EC. While further evolution of the Plan will occur, it is anticipated that it should include an assessment of all observational requirements of all WMO Programmes and co-sponsored programmes and identify those (including characteristics such as observational accuracy and resolution) that are needed to service all programmes or applications. It would also include implementation details for the various Pilot Projects, Demonstration Projects and their results, details of actions required to address revisions of the terms of reference (TOR) of the technical commissions, the WMO Programme structure, and WMO Secretariat budgetary, personnel and organizational implications. Many observing systems are outside of the remit of Member NMHSs; however their data provides a valuable contribution to WMO Programmes and Member NMHSs. Additionally, observational data from WMO Programmes and co-sponsored programmes is of value to organizations outside of WMO. The WDIP needs to address this from the aspect of improving data access across these boundaries. Data dissemination practices must be capable of respecting the data-sharing policies as designated by the owners of the observing systems including authorization of users.

2.5 The Roadmap or schedule below is broken into annual Phases timed according to sessions of EC. The items listed under each Phase required further elaboration since the dates of various events (e.g. Commission Meetings) are not yet confirmed, but they should be incorporated as the information becomes available. For historical purposes as well as further elaboration of the Plan, a description of the Preparatory Phase that occurred prior to Cg-XV is reproduced as well. The preparation of Version 1.0 of WDIP (WDIP V.1.0) that was endorsed by the EC in June 2008 was a crucial first step. WDIP V.1.1, and its subsequent revisions, will be important for informing the technical commissions, regional associations and the steering committees of GCOS, GOOS, GTOS and WCRP on WIGOS and WIS planning activities and to encourage their input into the process. Scheduling of as many regular sessions of technical commissions and regional associations as possible before 2010 would be most useful in obtaining their input in the planning process. EC-LXII (2010) marks the end of the active planning period since during its session the basic proposals to Cg-XVI will be prepared. Essential to taking this process forward will be the staffing of a WIGOS planning office in the WMO Secretariat as was proposed in III. (3) and IV. (3).

STATUS of the testing the WIGOS concept

III. Preparatory Phase - December 2006 – Cg-XV (May 2007)

(1) Document prepared for the EC Task Team on the WMO Integrated Global Observing Systems (EC-TT/WIGOS), February 2007; (Status: Completed);

(2) Report of EC-TT/WIGOS submitted to Cg-XV. This report to address the decision of EC-LVIII as contained in Resolution 13 (EC-LVIII); (Status: Completed);

(3) Formation of an internal Interim WMO Secretariat WIGOS Team under the chairmanship of a Director with participation from all relevant WMO Programmes. The Interim Secretariat WIGOS Task Team to address follow-up actions as required according to proposals by the EC-TT/WIGOS in preparation for presentation to Cg-XV. (Status: Not completed)

IV. Test of Concept, Phase I. Cg-XV (May 2007) – EC-LX (June 2008)

(1) Establish and update as appropriate the WIGOS Concept of Operations (CONOPS); (Status: Completed);

(2) Cg-XV through the EC-LIX establishes the EC-WG/WIGOS-WIS to oversee the development of WIGOS and WIS; (Status: Completed);

(3) Full time WIGOS Planning Unit organized in the WMO Secretariat (June 2007); (Status: Partially done);

(4) Coordinate with IOC regarding the WIGOS-WIS initiatives; (Status: Completed);

(5) Initiate the preparation of the draft WDIP v.1.0 (completion by Dec. 2007). Present the draft WDIP v.1.0 to EC-WG/WIGOS-WIS; (Status: Completed);

(6) Initiate first Pilot Projects:

   (a) Joint GOS-GAW Pilot Project to accelerate implementation of WIGOS-WIS; (Status: Initiated);

   (b) Initiation of Global Hydrological Network addressing a GCOS Requirement; (Status: (Status: Initiated));

   (c) Integration of AMDAR into WIGOS; (Status: Initiated);

   (d) Elaborating the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme; (Status: Initiated);

   (e) Integration of marine meteorological and other appropriate oceanic observations into the WMO Global Observing System; (Status: Initiated);

(7) Adjust draft WDIP and CONOPS v.1.0 as guided by EC-WG/WIGOS-WIS and present draft WDIP and draft CONOP v.1.1 to EC-LX; (Status: Completed);

(8) The agendas of technical commissions and regional associations should include an item relating to the Integration of WMO Observing Systems and should seek their “consensus inputs” to the WDIP to which the EC-WG/WIGOS-WIS would provide an input; (Status: done);

(9) At the Meeting of Presidents of Technical Commissions a major agenda item should be the WDIP to which the EC-WG/WIGOS-WIS would provide input. (Status: Partly completed);

(10) Initiate planning for the eight Demonstration Projects (see paragraph IX.); (Status: Done in the case of six);

V. Test of Concept, Phase II. EC-LX (June 2008) - EC-LXI (June 2009)

(1) EC-LX provides guidance for this phase; (Status: done);

(2) Review and update as appropriate the WIGOS CONOPS and WDIP; (Status: done);

(3) Initiate planning for the Pilot Projects concerning the integration of marine meteorological and oceanographic observations with WIGOS-WIS; (Status: done);

(4) The Pilot Projects (PP) begun in Phase I evaluated by corresponding Project Teams and SG-WIGOS; adjustments to the WDIP may arise from the evaluations; (Status: ongoing with a good progress: PP-I: Implementation Plan is missing; PP-II: change of the project; PP-III: Ongoing; PP-IV: Ongoing; PP-V: Ongoing);

(5) Coordinate with GTOS regarding terrestrial initiatives of relevance to WIGOS; (Status: pending, waiting for GCOS proposal on new PP);

(6) Additional Pilot Projects may be identified; (Status: done: EC-WG: reviewed and agreed with new proposals for GRUAN and GSICS Pilot Project);

(7) Demonstration Projects begun in Phase I evaluated by SG-WIGOS; adjustments to the WDIP may arise from the evaluations; (Status: Ongoing; project implementation plans to be submitted);

(8) Schedule possible concurrent sessions of CAS and CBS with joint agenda items regarding the integration of GAW and GOS into WIGOS; (Status: not feasible; Coordination underway; issue to be addressed/presented at CAS by appropriate WIGOS representative);

(9) Initiate work on the proposed revision to the WMO Technical Regulations; (Status: noted that some actions are required on Technical Regulations to be accomplished upon completion of Pilot and Demonstration Projects; initial discussion on the technical regulations is needed considering lessons learned);

(10) Revise WDIP and CONOPS and submit to EC–LXI for review and guidance; (Status: done);

(11) The agendas of technical commissions and regional associations should include an item relating to the Integration of WMO Observing Systems (including relevant components of co-sponsored observing systems) and should seek their “consensus inputs” to the WDIP to which the EC-WG/WIGOS-WIS would provide input; (Status: done at CHy-XIII, XIV-RA II, CBS TECO-WIGOS; XV-RA IV, CBS-XIV);

(12) Coordinate a way that RA working bodies can be involved into WIGOS activities in the Region (Status: started: initiated for two RAs (II, IV) that met during the period);

(13) Develop a reporting mechanism for Pilot and Demonstration projects; (Status: Ongoing);

(14) Elaborate basic definitions of WIGOS operations; (Status: Ongoing);

(15) Elaborate three areas of integration; (Status: done; significant revision achieved);

(16) Elaborate guidance on Demonstration Projects; (Status: Ongoing);

(17) Organize a workshop to facilitate the use of DCPCs in Pilot and Demonstration Projects; (Status: Pending);

VI. Test of Concept, Phase III. EC-LXI (June 2009) - EC-LXII (June 2010)

(1) EC-LXI provides guidance for this phase (note this is the last period for active planning before specific proposals are prepared for submission to Cg-XVI); (Status: done)

(2) Review and update as appropriate WIGOS CONOPS and WDIP; (Status: done)

(3) Agreed activities of Pilot and Demonstration Projects begun in Phase I and II should be completed and evaluated for viability of the WIGOS concept. Experiences from Pilot and Demonstration Projects to be reflected in the draft Implementation Plan for WIGOS; (Status: Majority of Projects have not been completed; in some cases, this was intentional and in other cases, this was due to the very limited time frame available and the lack of resources; most Projects will continue after Cg-XVI and their evaluation will be completed in due course)

(4) SG-WIGOS meets in 2009 to consider status of Demonstration and Pilot Projects, updates of CONOPS and WDIP and formulate recommendations for EC-WG/WIGOS-WIS; (Status: done)

(5) EC-WG/WIGOS-WIS meets in 2010 to elaborate draft recommendations for EC-LXII; (Status: done)

(6) The agendas of technical commissions and regional associations should include an item relating to the WIGOS and should seek their "consensus inputs" to the WDIP; (Status: done)

(7) Finalize elaboration of areas of integration; (Status: done)

(8) Elaborate standardized description of all observing networks contributing to WIGOS; (Status: done)

(9) Develop WIS component (e.g. DCPC) for each Demonstration and Pilot Project when needed; (Status: pending)

(10) Develop Guidance for NMHSs why and how to optimize their observing network by integration of their observing systems; (Status: pending)

(11) Coordinate with GCW regarding cryospheric initiatives of relevance to WIGOS; (Status: ongoing)

(12) Further WIGOS implementation activities for the period May 2009 – March 2010 were considered by the second session of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS-2), 6 - 8 May 2009, and were included in the Future Work Programme and Action Plan of EC WG (Reference: Final Report of EC-WG/WIGOS-WIS-2, Appendix IV).

PLANNING of the testing the WIGOS concept

VII. Test of Concept, Phase IV. EC-LXII (June 2010) - Cg-XVI (May 2011)

(1) EC-LXII to agree on the content of the submission to Cg-XVI regarding the implementation of WIGOS. This will include the proposed changes to the Technical Regulations, the revised roles and Terms of References of the various technical commissions, the adjustments to the WMO Programme structure, and the impact on the Secretariat budgets and personnel, proposed actions of Cg-XVI how to implement WIGOS;

(2) Subgroup WIGOS meets in 2010 to formulate advice and recommendations to EC-WG WIGOS-WIS;

(3) EC-WG WIGOS-WIS considers matters relating to the revision of the Technical Regulations, the TORs of technical commissions, and proposals regarding WMO Programme structure and content, and the WMO Secretariat structure will be addressed in this Phase;

(4) Coordinate a way that RA working bodies can be involved into WIGOS activities in the Region;

(5) Pilot and Demonstration Projects will be evaluated for sustained legacy within WIGOS if appropriate. Experiences and lessons learned from Pilot and Demonstration Projects will be reflected in WDIS and in the skeleton of WIGOS Implementation Plan;

(6) Test of concept WDIP and CONOPS are completed; the WDIS is completed and the skeleton WIGOS Implementation Plan (WIP) is developed;

(7) EC-WG WIGOS-WIS submits its final report on the Integration and recommendations to Cg-XVI.

VIII. Pilot Projects

Undertaking at the earliest possible stage several WIGOS Pilot Projects would be useful to address major issues on the integration process and would help in elaborating the WDIP. Pilot Projects will emphasize the role and contributions to be made by the Technical Commissions. In accordance with recommendations by Cg-XV, the following Pilot Projects were identified:

- *Pilot Project I:* **I**mprovement of **D**issemination of **O**zone (total column, profiles and surface) and **A**erosol observations through the WIS;

- *Pilot Project II:* **H**ydrological **A**pplications **R**unoff **N**etwork;

- *Pilot Project III:* Integration of AMDAR into WIGOS;

- *Pilot Project IV:* Elaboration of the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme in the context of WIGOS;

- *Pilot Project V***:** Integration of Marine Meteorological and other appropriate Oceanographic Observations into the WMO Integrated Global Observing System.

Additional projects can be initiated after approval of EC-WG/WIGOS-WIS.

IX. Demonstration Projects on the Development and Implementation of WIGOS at NMHSs

9.1 Helping Members to more fully understand WIGOS and keeping them up-to-date on its practical development should be considered as an essential component in WIGOS implementation. This can be achieved through launching Demonstration Projects in selected NMHSs. These Demonstration Projects will be linked to demonstrating aspects of the WIGOS concept and, at this early stage of WIGOS development, the Demonstration Projects should aim to be focussed on specific aspects of WIGOS and not be overly ambitious. Feedback and lessons learnt from these NMHSs will be extremely beneficial in understanding expectations of the WIGOS concept at a national or regional level. These projects will also have a high profile impact since they may involve functions of other observing networks that provide the delivery of time critical data and products, as well as other information, underlying the basic operations of NMHS. The Secretariat working with appropriate working bodies of regional associations and technical commissions would ensure regular coordination and communication between Members involved in Demonstration Projects.

9.2 The following countries expressed their willingness and intention to launch Demonstration Project: Kenya, Namibia and Morocco (RA I), Republic of Korea (RA II), Brazil (RA III), United States of America (RA IV), Australia (RA V) and the Russian Federation (RA VI). Proposals for new Demonstration Projects will be considered when submitted.

X. WIGOS web page

It is essential to have an effective website containing current information about WIGOS roles and tasks, related upcoming events and background information. The WMO Secretariat, in coordination with Members, relevant focal points for WIGOS in regional associations and technical commissions, will establish and update of a WIGOS web pages on the WMO Website by publishing information about WIGOS, including information on the current status of implementation of Pilot and Demonstration Projects, providing condensed information to various WIGOS user communities. (Status: Completed; See: http://www.wmo.int/pages/prog/www/wigos/index_en.html).

XI. Policy and Governance Aspects

To accomplish the goals above regarding the development of a WMO Integrated Global Observing System, adjustments must be made in the WMO Technical Regulations, the WMO Programme structure, the working structure and functions of the technical commissions, and of the WMO Secretariat. The motivations for WIGOS are focused to the objective of instituting an integrated end-to-end system of systems - comprised principally of WIGOS and WIS. The development of an effective and efficient system of governance to guide and implement it, arrangements for effective scientific and technical advisory mechanisms to develop, monitor and evaluate it, and an appropriate WMO Programme and WMO Secretariat structures to support it, will all be important and essential

components of the systems integration.

XII. WMO Technical Regulations (TR)

12.1 One of the principal strengths of WMO is the organizational and operational backbone provided by the *WMO Basic Document Series No. 2, Technical Regulations* (WMO-No. 49). The three volumes of the WMO Basic Document Series are supplemented by Annexes called Manuals, which have the same status as the Basic Documents and are aimed at facilitating cooperation between WMO Members, specifying their obligations and ensuring adequate uniformity and standardization in the practices and procedures employed. In addition to the Manuals, there is a class of WMO documentation, not part of the technical regulations, called *Guides* (e.g. the *Guide to the Global Observing System (WMO-No. 488).* The purpose of the *Guides* is to provide practical information on the development, organization, implementation and operation of the system, subsystem(s) or service in order to enhance both the participation of individual WMO Members in the activity and the benefits they may obtain from it. The *Guides* supplement the regulatory material contained in the TR and their Annexes.

12.2 The present structure of the Technical Regulations, Volume I describes the WWW/GOS, GDPFS, and GTS with other components of the overall WMO Programmes or systems distributed within the GOS or simply added on as they evolved. In order to effectively approach the integration of WMO Global Observing System, and to incorporate WIS, a fundamental reorganization and approach to the WMO TR is required. Undertaking this task early in the WIGOS and WIS planning activity will provide structure and organization to the overall effort, and will help in organizing the work programme required to implement WIGOS and WIS.

12.4 The revised structure of the TR must document the structure of WIGOS. The revised TR will need to be comprehensive and reflect all of the component systems. It will allow addressing the wide ranging multi-discipline issues and requirements for observational resources from all domains (atmosphere, ocean, and terrestrial). It should also build on and amplify the integration across surface-based and space-based observations.

12.5 In undertaking such a revision, a clearer vision for the purpose, scope, content and structure for continuous review and updating of the various elements that make up the TR, including the Guides, should be developed.

12.6 There is also an opportunity to make the TR easier to access, update and use. The application of electronic access through the Internet or similar technology for technical regulatory information should be considered as part of the integration activity. The role of WIS as the vehicle for this function may be a viable option.

XIII. WMO Programmes and Technical Commissions

13.1 It may be considered that one single WMO Programme should be assigned the responsibility to lead the planning of WIGOS and WIS and with its ultimate implementation and operation, noting that EC-LX emphasized that CBS should take a lead role for WIGOS. Participation during the integration by the other Programmes which currently have responsibility for components of the WMO Global Observing System will be crucial in this transition. The feasibility of this idea, in particular for the operation of WIGOS, should be investigated during the test of concept phase and incorporated into the draft WIGOS Implementation Plan for consideration by Cg-XVI.

13.2 As recognized in Resolution 30 (Cg-XV), the process leading to WIGOS would have a wide impact on the structure and functions of WMO including the WMO Technical Regulations, data policy, roles, terms of reference, and working arrangements of the technical commissions, the WMO Programme structure and the WMO Secretariat.

XIV. Jointly Sponsored Observing Systems

In progressing towards enhanced integration between WMO observing systems, it will be important that this be carried out in close coordination and cooperation with WMO's partner organizations that co-sponsor some of those systems. This will apply particularly to:

- The joint WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS);
- The WMO contribution to the joint IOC-UNEP-WMO-ICSU Global Ocean Observing System (GOOS);
- Those terrestrial/hydrological observing systems which serve as part of the FAO-UNEP-WMO-ICSU Global Terrestrial Observing System (GTOS);
- WCRP (WMO, IOC, ICSU) observing components.

LIST OF ACRONYMS

AMDAR	Aircraft Meteorological Data Delay
CBS	Commission for Basic Systems
CIMO	Commission for Instruments and Methods of Observation
CONOPS	Concept of Operations
DCPC	Data Collection or Production Centres
EC WG	Executive Council Working Group
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCW	Global Cryosphere Watch
GCOS	Global Climate Observing System
GDPFS	Global Data-Processing and Forecasting System
GOOS	Global Ocean Observing System
GOS	Global Observing System
GRUAN	Global Reference Upper-Air Network
GSICS	Global Space-based Inter-Calibration System
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission
QA	Quality Assurance
QC	Quality Control
QM	Quality Management
QMF	Quality Management Framework
QMS	Quality Management System
UNEP	United Nations Environment Programme
WCRP	World Climate Research Programme
WDIP	WIGOS Development and Implementation Plan
WIGOS	World Integrated Global Observing System
WIS	WMO Information System
WWW	World Weather Watch

Appendix V

WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

DEVELOPMENT AND IMPLEMENTATION STRATEGY

(WDIS)

Version 0.6

DOCUMENT VERSION CONTROL

Version	Author(s)	Date	Description
0.1	WIGOS-PO	Feb 2010	Reviewed by senior OBS staff
0.2	WIGOS-PO	Feb 2010	Reviewed and approved by D/WIGOS (D/OBS)
0.3	WIGOS-PO	March 2010	Feedback from CBS, CIMO, GCOS, senior consultants
0.4	CBS/CIMO	March 2010	Feedback from CBS-CIMO/WIGOS-CM
0.5	EC-WG	March 2010	Decision by EC-WG/WIGOS-WIS-3
0.6	WIGOS-PO	April 2010	Feedback from EC-WG/WIGOS-WIS

CONTENTS

EXECUTIVE SUMMARY **4**
1 INTRODUCTION **5**
2 BACKGROUND **5**
2.1 WMO STRATEGIC PLANNING **5**
2.2 WIGOS INITIATIVE **6**
2.3 VISION **6**
2.4 REQUIREMENTS AND OBJECTIVES **6**
2.5 SCOPE **7**
2.6 PHASES **7**
3 WIGOS IMPLEMENTATION COMPONENTS **8**
3.1 INTEGRATED GOVERNANCE AND DATA POLICY **9**
3.2 DATA DELIVERY AND INFORMATION SERVICES THROUGH WIS **10**
3.3 QUALITY MANAGEMENT AND STANDARDIZATION **10**
3.4 PLANNING, OPTIMIZING AND MONITORING OF OBSERVING SYSTEMS **11**
3.5 CAPACITY BUILDING **11**
3.6 COMMUNICATIONS AND OUTREACH **12**
4 WIGOS IMPLEMENTATION MANAGEMENT **12**
4.1 IMPLEMENTATION ENVIRONMENT **12**
4.2 RISK ASSESSMENT **12**
4.3 DELIVERABLES AND MILESTONES **13**
4.4 PROJECT MONITORING AND REVIEW **13**
4.5 ROLES AND RESPONSIBILITIES **14**
4.6 RESOURCES **15**
5 BENEFITS **16**
ANNEX ***17***
LIST OF ACRONYMS ***19***

EXECUTIVE SUMMARY

The WMO Strategic Planning process, approved by the Fifteenth World Meteorological Congress (Geneva, May 2007) guides the Organization in delivering its contributions to desired societal outcomes. The WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS) are strategic initiatives of WMO and were included in a set of eight high-level Expected Results (ERs), in particular "Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable surface-based and space-based systems for weather, climate and hydrological observations, as well as related environmental observations, based on world standards set by WMO and partner organizations". The success of WIGOS and WIS will have a major impact on all WMO Strategic Thrusts.

Based on the WMO strategic planning principles, the WIGOS Development and Implementation Strategy (WDIS) was developed in accordance with a decision of the WMO Executive Council in 2009 (EC-LXI). This decision underscored the importance of WIGOS to WMO Members as a framework for integrating WMO observing systems and for strengthening linkages with co-sponsored observing systems.

The objective of this strategy is to describe the steps that WMO, in collaboration with partner organizations, will follow to improve governance, management, and integration of WMO observing systems, and their contributions to co-sponsored systems, so as to ensure a coordinated, comprehensive, and sustainable system that meets the requirements of WMO Members and partner organizations. The Implementation Phase (2012-2015), described in this report, builds on lessons learned from the Test of Concept Phase (2007-2011) and lays the groundwork for the Operational Phase (from 2016 onward). As with WIS, the establishment of a WIGOS project office is essential to support the implementation phase.

In implementing WIGOS, it is imperative that the current management, governance and support activities be reviewed and aligned with WMO strategic planning and results-based management. This alignment should enable collaboration and promote cooperation and coordination at the technical, operational and administrative levels.

Achieving the benefits of WIGOS will require commitment from WMO Members, constituent bodies and from partner organizations who have agreed to collaborate in the implementation of WIGOS. Progress in WIGOS implementation will be directly related to the level of available resources. To move forward, substantial support to the Secretariat during the next financial period is required for the implementation phase. If the requested resources are not made available WIGOS implementation will be put at substantial risk.

Given the significance of active cooperation and enhanced coordination among the technical commissions, regional associations and WMO partners, appropriate steps will need to be taken to ensure that the integration process is incorporated in the work programmes and implementation plans of these entities. Regional associations and technical commissions will play a fundamental role in this process.

An integrated global observing system, supported by an integrated information system is essential to realizing the socio-economic benefits to be derived from a wide range of weather, climate, water and related environmental products and services. WIGOS will be an essential component of WMO's results-based management. It will ensure a coordinated WMO contribution to the cosponsored GOOS and GTOS and will be key to the successful implementation of GCOS in support of the UNFCCC, and in the development and implementation of the future Global Framework for Climate Services (GFCS). Through WIGOS and WIS, and their support for GOOS, GTOS and GCOS, WMO will make a fundamental contribution to the success of the Global Earth Observation System of Systems (GEOSS).

1 INTRODUCTION

The success of the past

For over 60 years WMO, through its Members, have advanced the observing and monitoring of weather, climate, water and the environment. This has led to a better understanding of the Earth System, and resulted in the delivery of improved and expanded services such as weather and air-quality forecasts, climate outlooks and predictions, and hydrological forecasts and assessments, which have resulted in improved decision making. These services now expand across timescales from severe weather warnings to weekly forecasts to seasonal outlooks, inter-annual and decadal variations and long term climate change projections with broad applications across social and economic sectors worldwide.

WMO has built productive alliances with partners that address the observational and monitoring needs associated with intersecting domains, particularly in respect of the climate system.

The challenge for the future

WMO Members need more extensive and advanced observations and information to improve both service quality and service delivery. An increasingly sophisticated user community is demanding that information reflects not only the complexity of the Earth's environment, but that it be delivered in such a way that can influence decision making at multiple scales. The challenge today is to achieve such ambitious results in a cost-effective manner. The WMO Integrated Global Observing System (WIGOS) is a key strategic initiative to optimize the efficiency and effectiveness of WMO services, leveraging the long-standing collaborative culture of WMO as well as new technologies and building on the investment by WMO and partner organisations in co-sponsored observing systems.

To meet this challenge, WMO Members must continue their legacy of integrated global observations and information. In doing so, observations and information from other domains, other observing systems, and other partners will be essential. Partnership agreements, governance structures, and interoperability arrangements among all of the above will present their own challenges. WIGOS and WIS must take full advantage of advances in observation and telecommunication technologies and in existing governance structures in order to increase science-based understanding of the Earth and its environment. The end result will be better prediction and services that provide the required information for the public and for policy and decision makers to ensure that national and international investments are being leveraged to the greatest extent possible.

2 BACKGROUND

2.1 WMO Strategic Planning

The WMO Strategic Plan recognizes that understanding the state of the environment is essential, and it depends upon the collection and open sharing of information, often using rapid and highly reliable methods.

The implementation of WIGOS will be an essential component of WMO's results-based management to address identified global societal needs. These needs consist of: (1) Improved protection of life and property, (2) Poverty alleviation, sustained livelihoods and economic growth and (3) Sustainable use of natural resources and improved environmental quality. WIGOS will contribute to all WMO Expected Results of the 2012-2015 Strategic Plan and is fundamental to the Strategic Thrust I "Improving Service Quality and Service Delivery".

In particular, WIGOS will deliver Expected Result 4, "Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable surface-based and space-based systems for weather, climate and hydrological observations, as well as related environmental observations, based on world standards set by WMO and partner organizations". The success of WIGOS will have a major impact on all WMO Strategic Thrusts areas.

2.2 WIGOS Initiative

The concept of WIGOS, as adopted by the Fifteenth World Meteorological Congress (Resolution 30, Cg-XV, 2007), originated from the widespread recognition that establishment of a coordinated approach to the management of diverse WMO observing systems would result in substantial benefits and efficiencies for Members and stakeholders.

Cg-XV requested that the development of WIGOS proceed concurrently with the planning and implementation of the WMO Information System (WIS). The combination of both efforts would allow for an integrated WMO end-to-end system designed to improve Members' capability to effectively provide a wide range of high quality services and to better respond to all WMO Programmes requirements.

As noted by Cg-XV, WIGOS, as it evolves, will impact the structure and function of WMO, including the WMO Programme structure, roles and responsibilities, terms of reference and working arrangements of technical commissions, the WMO Technical Regulations, and the WMO Secretariat.

In 2009, the Executive Council (EC-LXI) noted the value of including all observing systems important to the National Meteorological and Hydrological Services (NMHSs) in a single organizational framework. It underscored the need for a comprehensive, costed development and implementation strategy to address the technical and coordination challenges. This Strategy would include the designation of roles and responsibilities of WMO entities and partner organizations[1)] and the requirements for capacity building so that all WMO Members and partner organizations can benefit from WIGOS. The Strategy would also provide guidance to ensure enhanced coordination in four key areas: within WMO, with partners, with users and with the science and technology communities.

In response to Congress and the Executive Council, the WMO Technical Commissions, Regional Associations and Secretariat during the period 2007-2011 explored the concept of WIGOS through a series of Pilot Projects (by the technical commissions, sometimes in collaboration with partner organizations) and Demonstration Projects (by Members and the regional associations). This document builds on the lessons learned in the current Test of Concept phase.

Based on the Test of Concept phase of WIGOS, the basic characteristics of WIGOS are specified in the WIGOS Concept of Operations (CONOPS) document, which describes user needs for, and expectations from, the proposed system and how the system should operate to fulfil those needs. This document provides a logical transition of WIGOS from initial to full operational capabilities, recognizing that CONOPS will continue to be refined and will remain a basic reference document to this Strategy.

2.3 Vision

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 WMO Members in delivering their weather, climate, water and related environmental services. WIGOS will enhance the coordination of the WMO observing systems with those of partner organizations for the benefit of society.

WIGOS will be a framework enabling the integration and optimized evolution of WMO observing systems, and WMO's contribution to co-sponsored systems. Together WIGOS and 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 activities.

2.4 Requirements and Objectives

To enable improved service delivery, there is a need to improve the existing observing capability,

---

[1)] In this document "partner organizations" means: Intergovernmental, non-governmental and international organizations and groupings that operate, or co-sponsor with WMO, observing systems that contribute to WIGOS. The main partner organizations are UNESCO and its IOC, UNEP, FAO and ICSU and the main co-sponsored observing systems are GCOS, GOOS and GTOS; partner organizations also include GEO.

make it more cost-effective and sustain its operation. To ensure a coordinated, comprehensive, and sustainable system that meets the requirements of WMO and partners, improved governance, management, and integration of observing systems is needed.

Integration must be pursued to ensure interoperability and facilitate optimization across constituent systems. WIGOS will also enable resources to be used more effectively to overcome existing deficiencies and gaps in the constituent observing systems.

WIGOS is expected to provide timely, quality assured, controlled and documented long-term observations. Implementing Quality Management procedures is required to enable better utilization of existing and emerging observational capabilities.

In responding to evolving user requirements, WIGOS and WIS will meet the following objectives:

- Enable NMHSs to meet expanding national mandates of achieving higher national visibility with other environment related agencies. In doing so, WMO Members will be able to better respond to natural hazards, improve weather, water, climate and related environmental monitoring, and adapt to climate change and human-induced environmental impacts;
- Ensure a coordinated WMO contribution to the cosponsored GOOS and GTOS and contribute to the successful implementation of GCOS in support of the UNFCCC, and in the development and implementation of the future Global Framework for Climate Services (GFCS).
- Strengthen WMO's contribution to GEOSS;
- Provide a basis for sound decision making and enhance delivery of benefits to society.

An integrated global observing system, supported by an interoperable information system, will be a key contribution in realizing the socio-economic benefits to be derived from a wide range of weather, climate, water and related environmental products and services.

2.5 Scope

In meeting its objectives, WIGOS will not only serve WMO Members and partners but will also make a major and unique contribution to United Nations agencies that are focused on environmental stewardship, and along with WIS, will be a core contribution of WMO to GEOSS.

To achieve the objectives, which were demonstrated in the Test of Concept phase, the scope of WIGOS will encompass the following:

- *Requirements:* Provide a mechanism to meet new observational requirements of WMO Members and WMO partner organizations building on the existing Rolling Review of Requirements (RRR) process;
- *Integration:* Build upon and add value to the existing WMO observing components of Global Observing System (GOS), Global Atmosphere Watch (GAW), and World Hydrological Cycle Observing System (WHYCOS) with emphasis on integration of surface- and space-based observations;
- *Standardization:* Enhance observational data quality and homogeneity by introducing improved data quality and data management standards to better satisfy user requirements;
- *Access:* Improve access to, and utilization of, observations and products from WMO observing systems as well as those of co-sponsored systems.
- *Coordination:* Foster research and development activities and coherent planning for future observing systems and network optimization by working with all WMO Programmes and partner organizations.

2.6 Phases

The Test of Concept phase (2007 - 2011)

The development of WIGOS and its coordination with the development and implementation of WIS has been overseen by the Executive Council Working Group on WIGOS and WIS (EC-WG/WIGOS-WIS) established by EC (Resolution 3, EC-LIX, 2007). The EC-WG/WIGOS-WIS established a Sub-group

on WIGOS (SG-WIGOS) to manage technical integration activities, the development and implementation of the WIGOS concept, and to provide recommendations to EC-WG/WIGOS-WIS. The Secretariat has provided support to EC-WG/WIGOS-WIS and SG-WIGOS.

In accordance with the recommendation of Cg-XV, development and implementation of the WIGOS concept proceeded in the phases defined by the annual sessions of the Executive Council. The WIGOS Test of Concept Development and Implementation Plan (WDIP) with the Strategic Roadmap was developed by EC-WG/WIGOS-WIS, taking into account the WIS Project and Implementation Plan, and updated annually.

The seven Pilot Projects, initiated by the technical commissions, addressed major issues of the integration process, including testing the WIGOS concept and identifying problem areas. Lessons learned emphasized the role and contributions to be made by the technical commissions and relevant partners in the integration process.

In accordance with recommendations by EC-LX, several Demonstration Projects were initiated by WMO Members. At least one 'test-bed' Demonstration Project was carried out within each regional association. Feedback and lessons learned from Demonstration Projects facilitated the understanding of expectations on WIGOS at national and regional levels, including importance of capacity-building activities.

The status of implementation of WIGOS Pilot and Demonstration Projects is posted on the WIGOS Web page at http://www.wmo.int/pages/prog/www/wigos/index_en.html as a communications and outreach activity.

WIGOS Implementation phase (2012 - 2015)

The Implementation phase, to be undertaken between 2012 and 2015, will focus on developing and implementing a framework for improved governance, management, integration and optimization of the multiple observing systems coordinated by WMO and its partner organizations.

WIGOS Operational phase (2016 onward)

Once this framework is established, WIGOS will enter its Operational phase. During this phase, WIGOS constituent observing systems and networks will continue to evolve to improve service delivery and support decision making in response to the evolving needs of users and technological opportunities. Although this phase is not limited in time, it is anticipated to include an initial period of rapid enhancement of observing capabilities between 2016 and 2019 in order to meet the highest priority needs.

3 WIGOS IMPLEMENTATION COMPONENTS

In light of the cross cutting nature of WIGOS and its impact on organisational process and structure identified by Cg-XV, the success of WIGOS must not be detrimental to the ongoing maintenance and operational effectiveness of existing observing systems or to their governance. In order to manage these risks (See section 4.2), the key implementation components for this Strategy must include:

1. Integrated Governance and Data Policy;
2. Data delivery and information services through WIS;
3. Quality Management and Standardization;
4. Planning, optimization and monitoring of observing systems;
5. Capacity Building;
6. Communications and Outreach.

A brief description of the major implementation aspects is given in the following paragraphs.

3.1 Integrated Governance and Data Policy

WIGOS will address high-level observing requirements by establishing an effective and sustained organizational, programmatic, governance and procedural structure. This structure will enable a common standardization approach, uniform implementation of WMO regulations, and data integration and interoperability across all WMO observing systems. It will also provide a single focus for integrated and coordinated operational management of all WMO observing systems and a mechanism for coordination with WMO co-sponsored and contributing observing systems.

Therefore, in implementing WIGOS it is imperative that the current management, governance and support activities be reviewed and aligned with WMO strategic planning and results-based management. This alignment should enable collaboration and promote cooperation and coordination at the technical, operational and administrative levels.

Central coordination through the WMO Secretariat is essential for successful WIGOS implementation. In addition, the long-term commitment and effort of WMO Members; greater international cooperation; and sustained technological, capacity building, and financial support for developing and least developed countries is important.

The development of an effective and efficient system of governance will require adequate scientific and technical advisory mechanisms to develop, monitor, and evaluate the WIGOS implementation process. The WMO Executive Council, through its EC-WG/WIGOS-WIS, will continue to steer and monitor WIGOS activities to ensure the broadest possible collaboration and cooperation.

Given the significance of active cooperation and enhanced coordination among the technical commissions, regional associations, and WMO partners, appropriate steps will need to be taken to ensure that the integration process is incorporated in the work programmes and implementation plans of these entities. For this purpose, it is highly desirable that an Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) be established. This group would replace the Subgroup on WIGOS and would be expected to:

- Coordinate, review, refine, and assess the development and implementation of WIGOS;
- Provide technical guidance and assistance for the WIGOS development, planning, and implementation activities, such as standardization and development of WIGOS databases;
- Advise regional associations on WIGOS implementation activities;
- Advise technical commissions on the standardization process and related activities;
- Coordinate cooperation at a technical level with WMO partner organizations, including UNESCO and its IOC, UNEP, FAO, and ICSU (who would be invited to participate in this activity);
- Coordinate the WMO contribution to GOOS, GTOS, GCOS and GEOSS;
- Address major issues identified by EC-WG/WIGOS-WIS;
- Advise EC-WG/WIGOS-WIS on further development and implementation of WIGOS; and
- Report to EC-WG/WIGOS-WIS.

Furthermore, for WIGOS to be successful, it will be necessary to identify terms of reference for task teams at the regional and commission levels and, when appropriate, with representatives of partner organizations. Major tasks should be assigned as follows:

- Regional task teams will need to coordinate planning and implementation of WIGOS on the regional level with WIS implementation and, eventually, with the implementation of GFCS in order to optimize regional and national observing systems;
- Inter-Commission Task Teams, which should include representatives of partner organizations, will need to address standardization, observing system interoperability, data compatibility, data management, Quality Management System (QMS) procedures, performance monitoring, WMO regulatory material issues, and proposed improvements in observing networks/systems.

Improving coordination will be an ongoing activity at policy, technical, and Secretariat levels. This will

need to be supported by a high-level reconciliation mechanism defined in the WMO-UNESCO-IOC-UNEP-FAO-ICSU Memoranda of Understanding (MOU) in order to resolve possible problems in data policy, product delivery, and other governance issues. The existing Interagency Coordination and Planning Committee for Earth Observations (ICPC) should be strengthened and used for such coordination activities.

These interagency and inter-observing system coordination mechanisms will need to be complemented and supported through national coordination arrangements among NMHSs and their partner organisations and coordinated with similar national implementation mechanisms for GCOS, GOOS, GTOS, and GEOSS.

Data Policy

A key part of integrated governance will be to achieve compatible and as far as practical consistent data policies. WIGOS will respect the data policies of partner organizations and will adhere to Resolution 40 (Cg-XII) and Resolution 25 (Cg-XIII). It will strive to ensure that the conditions placed by the originator on the additional data and products are respected and made known to initial and subsequent recipients for the exchange of weather, climate, and water related data and products, including guidelines on relationships in commercial meteorological and hydrological activities.

Although data policies are similar across WIGOS contributing organizations, there are some differences. Therefore it may be necessary to follow a two-fold approach, consisting of a common set of data sharing principles supplemented by specific practices of those contributors.

3.2 Data Delivery and Information Services through WIS

The WIGOS pilot projects, such as the JCOMM/IODE Ocean Data Portal and the CAS/GAW projects, have supported the effectiveness of WIS as the core interoperability layer of WIGOS. WIS allows otherwise independent observing systems to move data between them, as well as providing the standards for more effective data management. 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. A detailed description of WIS is presented in the WIS Project and Implementation Plan.

As noted by EC-LXI (2009), WIGOS is crucially dependant upon effective WIS support and services and should proceed in close coordination with WIS implementation. This includes the specialized data collection means as well as the generation, collection, management and handling of related metadata[2)] that is essential to ensuring data within WIGOS meet the stringent traceability requirements of special users such as climate scientists. The metadata also play an important role in the discovery and access to observations and products. The needed metadata therefore includes both that which pertain to the observational information as well as that which describes the observational products and which is necessary to share the information.

3.3 Quality Management and Standardization

Quality Management

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.

WIGOS should embrace QMF procedures to ensure that observations, records and reports on weather, water, climate and other environmental resources, operational forecasts, warnings, related information and services are of identified quality, and in compliance with relevant joint standards

[2)] It is necessary to clearly distinguish between station/platform metadata (“WIGOS metadata”) and WIS metadata needed for Data Discovery, Access and Retrieval (DAR) services that WIS must provide. Both are essential to WIGOS

agreed upon with other international organizations.

This should be based on agreed-upon quality assurance and quality control standards, with the goals of developing and implementing an integrated QMS; in doing this, it will deliver reliable and timely data streams with adequate quality control and relevant metadata.

WIGOS QMF implementation strategy will specify all processes of QMS for observational networks. Attention will also be paid to the guidance on how to manage observational networks and observing subsystems to more fully meet QMF requirements.

Standardization

As specified in CONOPS, a principal requirement for integration is the standardization in three key areas: Instruments and Methods of Observation; WIS information exchange and discovery; Quality Management Framework.

As part of the implementation strategy, a successful 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.

3.4 Planning, Optimizing and Monitoring of Observing Systems

Coordinated planning based on RRR process has a great potential to enhance observing system capabilities and to increase cost-effectiveness of observing efforts and investments.

This activity will be performed through the following:

- A systematic rolling review of observing requirements from each of the user communities it 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 capabilities and the potential of new technology to replace or complement current observing capabilities.

This process, conducted with close involvement of both the operational and research communities, should result in Statements of Guidance that can be either specific to each constituent system or commonly applicable to all.

The coordinated planning of the evolution and enhancement of observing systems in response to these Statements of Guidance must be conducted in a coordinated way across observing systems, as far as practical, through systematic exchange of information, consultation, with the aim to develop synergy. This shall be pursued when defining sensor specifications, locations and operating mode, when sharing observation infrastructure and organizing data management and distribution. The role of regional associations (RAs) and technical commissions (TCs) will be indispensable in the overall process.

3.5 Capacity Building

An effective capacity-building and training strategy is an essential component of the WIGOS framework. A coordinated capacity-building effort should assist developing and least developed countries to improve and sustain their contributions to WIGOS observing systems, including access to and effective utilization of observations, data and products, and related technologies. As a key factor in successful WIGOS implementation, capacity building activities at national and regional levels will be focused on:

- Institutional mandates and policies;
- Infrastructure establishment and/or strengthening;
- Human skills development and training;
- Technical assistance; and

- Technology transfer.

To take advantage of WIGOS benefits and to ensure that information and services are used to the maximum extent possible, transfer of technological innovations and development of decision support tools will be essential. For this purpose, specialized education and training activities should be reflected in the Regional WIGOS Implementation Plans, especially for NMHSs of Least Developed Countries (LDCs) and Small Island Developing States (SIDS).

3.6 Communications and Outreach

Given numerous and geographically diverse stakeholders, development and implementation of a WIGOS communications and outreach strategy will be one of the key prerequisites to the success of WIGOS. This strategy should comprise the following core areas:

- Interaction of the WIGOS Project Office with the secretariats of the various WMO and WMO-co-sponsored observing systems and user programmes. The Office should also coordinate with related activities such as the Global Cryosphere Watch, GCOS and GEOSS, and with the coordinated WMO contribution to the future GFCS;
- Active involvement of regional associations and technical commissions. The WIGOS implementation strategy includes establishment of regional/inter-commission expert teams. These teams will participate in the development and implementation of WIGOS at the regional/ technical commission levels;
- Establishment and management of a WIGOS portal. This portal will provide relevant information to stakeholders on WIGOS development, implementation, and standardization processes and on the communications and outreach strategy;
- Proactive identification of new users as WIGOS evolves.

4 WIGOS IMPLEMENTATION MANAGEMENT

4.1 Implementation Environment

The development and testing of the WIGOS concept after Cg-XV occurred during a long and very challenging global economic recession. This situation affected many NMHSs that had already been facing reduced budgets and therefore greater pressure to reduce operational and maintenance costs. The Test of Concept phase of WIGOS has also occurred alongside a rapidly increasing interest in climate change. Moreover, climate assessments require far more vigilance in addressing the sustainability and long-term homogeneity of data being used to assess climate variability and change.

The financial crisis and competing priorities have the potential to divert funds from core observing systems at a time when they are most needed to meet society's needs. There is also considerable competition for funds between traditional *in situ* and space-based observations. While advances in numerical modelling and assimilation processes clearly show the benefits of remote sensing to weather and climate models, they also highlight the important complementarity provided by *in situ* observations. Therefore WIGOS will have to be supported by appropriate awareness raising and outreach activities that reinforce the importance of both *in situ* and space-based observations and their integration.

For WIGOS to succeed, the external environment as well as the risks associated with the integration of previously independent systems must be managed. In particular, there is a need for a WIGOS Project Office with sufficient staffing and funding to carry out the necessary tasks detailed in Section 3 and reflected in the deliverables in Section 4 (see Figure 1). Noting that there is already one person in the WIGOS Planning Office, it is recommended that at least two additional staff be provided.

4.2 Risk Assessment

An initial risk assessment identifies the implementation of WIGOS as a high risk project for the following reasons:

- ***Complexity of the project***. The project involves diverse stakeholders and needs a high level of cooperation among them. Implementation activities must be integrated into the strategic planning of regional associations as well as that of individual Members to ensure connectivity and to encourage synergies between national, regional and global activities;
- ***Basic infrastructure***. This must be in place to allow improved data acquisition systems, data management systems, and QMS to function effectively;
- ***Resources***. Substantial investment of resources and expertise are needed to support WIGOS development and implementation.

Following EC-LXII, a skeletal WIGOS Implementation Plan will be formulated utilizing CONOPS, WDIP and WDIS. This will be submitted for approval by the President on behalf of the EC for transmission to Cg-XVI. Between Cg-XVI and Cg-XVII, a complete WIGOS Implementation Plan (WIP) will be developed including a detailed risk assessment and management plan. Risks will need to be clearly identified and managed at various points throughout the project, including the development of associated mitigation and contingency plans. The Secretariat will take a coordinating role in overall risk management by providing a focal point for these activities.

4.3 Deliverables and Milestones

Upon the approval by Congress, WIP will address a list of tasks associated with the key deliverables and milestones. The task list should include risk management plans and time lines for each task, along with details of task leaders. Figure 1 shows the key milestones, including routine WIGOS related reports to EC and Congress, and timelines. Some tasks such as coordination with WIGOS component systems will be essential activities throughout and beyond the Implementation phase. The WIGOS project documentation will be a key deliverable early in the period, while Regulatory Documentation will be the focus in later phases. Capacity building will focus on communications and outreach at first and then move to the development of guidelines and training material later in the project. Pilot and demonstration projects will continue to be an important activity in the later implementation stages, especially to assist developing countries including LDCs and SIDS to more fully benefit from WIGOS.

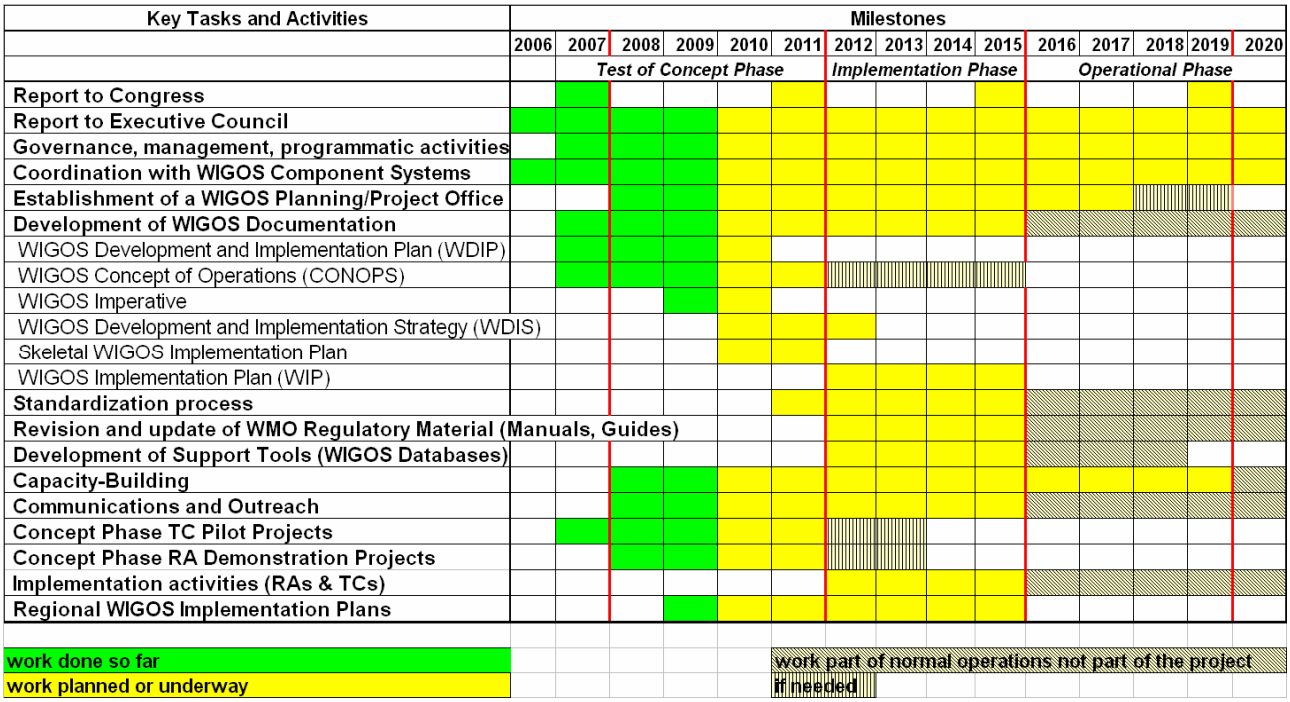

Figure 1: Key Tasks, Activities and Milestones

4.4 Project Monitoring and Review

The EC-WG/WIGOS-WIS will remain the prime coordinating body for WIGOS. As noted in paragraph 5.1, ICG-WIGOS would ensure coordination across all technical levels.

Depending on the availability of resources, the WIGOS Project Office will provide the operational support to overall WIGOS activities. In addition to supporting the EC-WG/WIGOS-WIS and ICG-WIGOS, it will support the WIGOS coordination functions of the working bodies of RAs and TCs and other contributing programs and mechanisms. It will continuously monitor WIGOS implementation activities, coordinate follow-up actions and regularly report to all concerned.

All information related to the implementation of WIGOS will be available on the Secretariat WIGOS web page as a component of the WIGOS communications and outreach strategy.

4.5 Roles and Responsibilities

As requested by Cg-XV, Members, international partner organizations and related programmes have begun to collaborate actively in the development and implementation of the WIGOS initiative. It is recognized that full implementation of WIGOS requires long-term commitments from all participants and mutual understanding by all partners to accomplish their current and planned observational activities in a coordinated manner. WIGOS implementation will require significant effort and time.

In order to move towards full WIGOS operations, the entities listed below are considered to have essential roles and should assume, along with their general terms of reference and their commitment to the implementation of WIS, the following responsibilities:

WMO Members:

- Design, develop and implement national observing systems according to the Vision for global observing systems in 2025; GAW Strategic Plan (2008-2015); WHYCOS guidelines; GCOS, GOOS and GTOS Implementation Plans;
- Implement standards in accordance with WIGOS regulatory material;
- Participate in national, regional and international cooperation mechanisms;
- Provide adequate resources for WMO Secretariat support for WIGOS implementation, either through regular WMO budgetary process, or in kind, via secondments and/or through contributions to the Trust Fund.

Executive Council:

- Steer and monitor WIGOS development and implementation activities, and achieve the broadest possible collaboration, cooperation and coordination of all stakeholders;
- Coordinate WIGOS and WIS implementation plans and activities;
- Provide advice, guidance and support for the implementation of WIGOS.

Regional Associations:

- Develop and coordinate Regional WIGOS and WIS Implementation Plans,
- Incorporate WIGOS and WIS in their operating plans and work programmes;
- Identify priority areas where observational requirements can be met more effectively through integration of surface-based and space-based subsystems;
- Determine regional priorities for observing system development and provide input for regional observing system needs into the RRR Process;
- Provide advice and feedback to Members on WIGOS related activities;
- Encourage proactive involvement of Members in regional WIGOS and WIS implementation activities.

Technical Commissions:

- Develop guidance for the design and evolution of observing systems utilizing the RRR Process;
- Develop WIGOS standards, including metadata standards, in collaboration with partners;
- Provide technical guidance and advice to Members and Regional Associations on WIGOS;
- Review, update and harmonize WMO Regulatory Material;

- Coordinate WIGOS and WIS implementation;
- Integrate WIGOS activities within work programmes of relevant groups and/or expert teams;
- Provide the technical lead for WIGOS through Commission for Basic Systems (CBS) and Commission for Instruments and Methods of Observation (CIMO).

WMO Secretariat:

- Ensure management of, and support to, the WIGOS implementation process;
- Establish a WIGOS Project Office;
- Develop proposals for programmatic and governance structures in support of WIGOS taking into account WMO's strategic directions;
- Support WIGOS and WIS implementation;
- Ensure proper coordination with other observing systems contributing to the GFCS as it develops;
- Coordinate and collaborate with partner organizations and programmes in WIGOS activities;
- Support regional associations and technical commissions in developing their WIGOS implementation strategies and projects, including outreach and capacity-building activities;
- Work with Members and donors to provide adequate resources for WIGOS implementation.

Partner Organizations:

- Collaborate with WMO in establishing appropriate coordination mechanisms;
- Coordinate with WMO to create and maintain interoperability among observing systems;
- Coordinate with WMO on data policy.

4.6 Resources

It should be underlined that the timely completion of the WIGOS Implementation phase in the sixteenth financial period 2012-2015 critically depends on adequate resources.

The investment for fully implementing WIGOS should be a significant focus of Member's development and implementation plans. In addition, extra resources will need to be provided through WMO Secretariat for both staff and non-staff costs for the implementation and coordination that are beyond the normal programmatic activities of the Secretariat. As a result, additional budgetary resources need to be allocated to the WIGOS implementation phase.

To ensure the funding needed for WIGOS implementation, the following resources should be considered:

- WMO Regular Budget for WIGOS implementation support activities;
- WIGOS Trust Funds to supplement WMO Regular Budget;
- In kind contributions;
- Staff secondments;
- Voluntary Co-operation Programme funds for WIGOS related technical cooperation and capacity-building activities.
- Regional fundraising activities to support WIGOS.

Taking into account the role, responsibilities and scope of the work required, an adequately staffed and resourced WIGOS Project Office needs to be established within the Secretariat. This will ensure a suitable project management function, improved coordination and cooperation with technical commissions, regional associations and partner organizations essential for WIGOS implementation.

In response to the request for a WIGOS comprehensive costed development and implementation strategy, the Secretariat has provided the detailed cost statement of the resources needed (see Annex, Tables 1 and 2).

5 BENEFITS

In order to meet the evolving needs of WMO Members, there is a well-recognized need to improve existing observing capability, make it more cost-effective, sustain its operation and enhance service delivery. Integration of respective components and systems must be pursued to ensure interoperability, and optimize constituent observing systems within a WIGOS framework. WIGOS will also enable resources to be used more efficiently and effectively to overcome existing deficiencies and gaps.

WIGOS is expected to provide timely, quality-assured, quality-controlled and well-documented long-term observations. Implementation of Quality Management procedures will be required to enable enhanced utilization of both existing and emerging observational capabilities. In meeting the evolving user requirements, WIGOS together with WIS will:

- Enable the evolution and integration of WMO observing systems and enhance collaboration with its partner organizations: this will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services (across weather, climate and water domains) in a cost-effective manner;
- Result in enhanced observing capabilities by improving integration between its surface- and space-based components;
- Enable WMO Members to meet expanding national mandates which are calling for increasing coordination and integration to help them better respond to natural hazards, improve weather, water, climate and related environmental monitoring, and adapt to climate change and other human-induced environmental impacts;
- Enhance operational components of WMO Programmes, especially in Developing and Least Developed Countries and ensure essential WMO support for the observational and information elements of the future GFCS;
- Contribute strongly to GOOS, GTOS, GCOS and GEOSS; and lastly,
- Provide a basis for sound decision making and enhance delivery of services to society in all WMO applications areas.

An integrated global observing system, supported by an interoperable information system, will be essential for realizing the socio-economic benefits from the wide range of weather, climate, water and related environmental products and services based on WMO's core competencies in environmental monitoring.

_____

Annex

Table 1: WIGOS Secretariat activities and funds needed for 2012-2015 (CHF)

No	*Activities* [1)]	*Required funds*
1	Governance, management, programmatic activities	500,000
2	Coordination with WIGOS Component Systems	100,000
3	Development of the WIGOS Implementation Plan	10,000
4	Standardization process	100,000
5	Develop, revise and update of WMO Regulatory Material (Manuals, Guides)	100,000
6	Development of WIGOS Databases	
	Operational DB	200,000
	Standardization DB	200,000
	User Requirements and Operational Capabilities DB	200,000
7	Capacity Building	200,000
8	Communications and Outreach	50,000
9	Translation and publication costs	3,000,000
	TOTAL:	**4,660,000**

[1)] ***Breakdown for each activity is given below*** (these costs are fully related to integration activities with respect to the WIGOS Implementation Phase)***:***

1. Resources amounting to CHF 500K cover: four meetings of the EC WG WIGOS-WIS (4x40K=160K); four meetings of the ICG-WIGOS (4x25K=100K); six regional WIGOS implementation-coordination meetings (6x40K=240K);

2. CHF 100K is allocated to convene two WIGOS coordination meetings of experts representing GOS, GAW, WHYCOS, GCOS, GOOS, GTOS (2x50K=100K);

3. CHF 10K is allocated for consultant services to assist the Secretariat in the preparation of the WIP;

4. CHF 100K covers expert services to assist countries to carry out Site classification (50K) and Maintenance classification (50K) for each WMO region;

5. CHF 100K covers consultant services to develop WIGOS-related amendments to the Manual on the GOS (10K), Guide on the GOS (10K), CIMO Guide (20K), WHYCOS Guidelines (10K), Guide to Marine Meteorological services (10K), GAW Guide (10K) and to develop WIGOS Manual (30K) (this does not include translation and publication costs);

6. Resources of CHF 200K for each of three WIGOS DBs cover: two expert meetings (2x25K=50K); development of the DB' technical specifications (40K); development of software (50K); development of the Operations Manual (10K); implementation of DBs, including data transfer and input (50K);

7. CHF 200K is allocated to convene one WIGOS training workshop in each WMO Region (6x30K=180K) and accomplish four expert fact-finding missions (4x5K=20K);

8. CHF 50K covers the development of the WIGOS Portal (10K); representation of WIGOS PO at the regional/inter-commission expert team meetings (20K) and at the relevant coordination meetings of partner' organizations (20K).

Table 2: WIGOS Project Office staff resources needed for a period 2012-2015

No	*Position*	*Activities* [2)]*/Duties*	*Staff cost for 2012-2015 (CHF)*
1	WIGOS Project Manager [3)]	1-8: To lead the WIGOS Project Office taking into consideration lessons learned from existing and future WIGOS projects. This person would also manage and review the implementation of WIGOS, undertake the necessary liaison within the Secretariat and stakeholders and to oversee all the projects within WIGOS.	900,000
2	WIGOS Support and Capacity	8: To accomplish general duties, such as outreach activities and capacity building. In particular, to assist with capacity building in Member countries and to work with Education and Training (ETR) and Development Cooperation and Regional Activities (DCR) to ensure	500,000

	building Manager	Members, especially in least developed countries, reap the full benefits of WIGOS. An important role of this position will be to maintain the project register on activities in collaboration with other observing system staffs and task leaders including those not resident in the WMO Secretariat.	
3	WIGOS Technical Documentation Manager	5: To review existing Technical Documentation and Regulations for observing systems in order to prepare appropriate updates as well as an initial WIGOS Manual and related guidelines, and to support the expert teams in production of other guidance material such as those needed on the preparation and maintenance of metadata. This officer will also play a key role in the review of technical regulations in coordination with WIS.	500,000
		TOTAL:	**1,9 million**

2) Activities in accordance with Table 1

3) The WIGOS Project Manager post is established and financed from the WMO regular budget

List of Acronyms

CBS	WMO Commission for Basic systems
CEOS	Committee on Earth Observation Satellites
CONOPS	Concept of Operations
CIMO	Commission for Instruments and Methods of Observations
CSIS	Climate Services Information System
D/OBS	Director, Observing and Information Systems Department
DMS	Data/metadata management system
DRR	Disaster Risk Reduction
EC	Executive Council
EUCOS	EUMETNET Composite Observing System
EC-WG/WIGOS-WIS	Executive Council Working Group on WIGOS and WIS
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Services
GOOS	Global Ocean Observing System
GOS	Global Observing System
GTOS	Global Terrestrial Observing System
ICG-WIS	Inter-Commission Coordination Group on WIS
ICG-WIGOS	Inter-Commission Coordination Group on WIGOS
ICPC	Interagency Coordination and Planning Committee for Earth Observations
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission
JCOMM	WMO/IOC Joint Commission for Marine Meteorology
LDCs	Least Developed Countries
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NMHS	National Meteorological and Hydrological Service
QA	Quality Assurance
QC	Quality Control
QMF	Quality Management Framework
QMS	Quality Management System
RA	Regional Association
RRR	Rolling Review of Requirements
SG-WIGOS	Sub-group on WIGOS
SIDS	Small Island Developing States
TC	Technical Commission
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WDIP	WIGOS Development and Implementation Plan
WDIS	WIGOS Development and Implementation Strategy
WHYCOS	World Hydrological Cycle Observing System
WIGOS	WMO Integrated Global Observing System
WIP	WIGOS Implementation Plan
WIS	WMO Information System
WWW	World Weather Watch

_____

Appendix VI

DRAFT RESOLUTION 3.4/3 (EC-LXII) - IMPLEMENTATION OF WIGOS

THE EXECUTIVE COUNCIL,

Noting:

(1) Resolution 3 (Cg-XV) – Global Observing System,

(2) Resolution 30 (Cg-XV) – Towards enhanced integration between WMO observing systems,

(3) Resolution 3 (EC-LIX) – Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System,

(4) The report of the third Session of the EC-WG/WIGOS-WIS,

Reaffirming that an integration process would be a complex undertaking that would stretch over several years through WIGOS Implementation and Operational phases and require the full support of all Members to be successful;

Considering the continuing need for the activities of the EC-WG on WIGOS-WIS to:

(1) Guide and monitor the development and implementation of WIGOS and WIS as defined by Cg-XV;

(2) Provide advice and guidance on the development of a WIGOS Implementation Plan;

(3) Refine the WIS Development and Implementation Plan and ensure coordination between WIGOS and WIS activities to allow for an integrated WMO end-to-end system;

(4) Monitor and evaluate the further progress of WIGOS/WIS Projects to help in elaborating the WIGOS Implementation Plan;

Further noting that resources are needed to ensure:

(1) The development and publishing of WIGOS documentation;

(2) The timely completion of the WIGOS Implementation Plan;

(3) The development of WIGOS operational and standardization databases;

(4) The essential support to the WMO Secretariat to effectively foster the full implementation of WIGOS in the sixteenth Financial Period (2012-2015);

Decides:

(1) To keep in force Resolution 3 (EC-LIX);

(2) To adopt the updated versions of the WIGOS Development and Implementation Plan (WDIP) and the WIGOS Concept of Operations (CONOPS), as presented as INF 3.4 (1) and INF 3.4 (2) to the Session, with the understanding that they might be further refined in view of the lesson learned from the WIGOS Test of Concept Phase;

(3) To endorse, the further development of the “WIGOS Development and Implementation Strategy” (WDIS) as presented INF 3.4 (3) in to the Session with a view to presenting it to Cg-XVI for endorsement;

(4) To propose to Cg-XVI to include the Manual on WIGOS in the list of WMO Mandatory publications;

(5) To propose to Cg-XVI the establishment of an Inter-commission Coordination Group on WIGOS with the Terms of Reference specified in Annex to this draft resolution.

Requests regional associations and technical commissions:

(1) To incorporate WIGOS implementation activities in their operating plans and work programmes;

Encourages Regional Associations:

(1) To continue their WIGOS implementation planning as guided by the WDIS;

(2) To establish WIGOS related Task Teams and to undertake regionally focused WIGOS activities;

Urges Members:

(1) To provide resources in the form of contributions to the WIGOS Trust Fund and/or secondment(s);

Requests the Secretary General:

(1) To provide the necessary assistance and Secretariat support for the EC-WG/WIGOS-WIS;

(2) To prepare, in close cooperation with the chairperson of the EC-WG/WIGOS-WIS, the comprehensive EC Report on the integration between WMO observing systems for submission to Cg-XVI;

(3) To publish the “WIGOS Imperative”, as presented in INF 3.4 (4) to the Session.

ANNEX TO DRAFT RESOLUTION 3.4/3 (EC-LXII)

TERMS OF REFERENCE FOR INTER-COMMISSION COORDINATION GROUP ON WIGOS (ICG-WIGOS)

- To coordinate and evaluate WIGOS related activities carried out by relevant technical commissions;
- To provide technical guidance and assistance for the planning, implementation and further development of GOS, GAW and WHYCOS as core components of WIGOS, including standardization of instruments and methods of observation, WIS information exchange and discovery and Quality Management Framework;
- To advise the regional associations on the technical aspects of WIGOS implementation activities in respective regions;
- To maintain close cooperation at a technical level with WMO's partner organizations such as UNESCO and its IOC, UNEP, FAO, and ICSU and co-sponsored observing systems GCOS, GOOS and GTOS;
- To address major issues identified by the EC Working Group on WIGOS and WIS and provide technical advice on the further development and implementation of WIGOS;
- Report to the EC Working Group on WIGOS and WIS.

_____

Appendix VII

Work Programme and Action Plan of the EC-WG/WIGOS-WIS (April 2010 – April 2011)

No	TOR area/Activities	Responsibility	Target	Comments
1	**Guidance on the development and implementation of WIGOS**	Chair, EC-WG		
1.1	Refine and complete CONOPS [1)]	Chair, SG-WIGOS	II. 2011	
1.2	Complete WDIS	Chair, EC-WG	II. 2011	
1.3	Develop the skeleton WIGOS Implementation Plan (WIP)	CBS President	II. 2011	
2	**Coordination of WIGOS and WIS**	CBS President		
2.1	Linking of WIGOS and WIS requirements.	Chair, EC-WG Chair, ICG-WIS	-	Coordinated through WIGOS PO and WIS PO
2.2	Coordinate involvement of RA /TC in WIGOS-WIS activities	Secretariat	-	
2.3	Organize a workshop on the operations and implementation of DCPC	WIS PO		Depends on the WP development
3	**Monitoring of development and implementation of WIGOS and implementation of WIS, incl. projects**	Chair, EC-WG		
3.1	Monitor WIGOS implementation	WIGOS PO	-	
3.2	Monitor WIS implementation	WIS PO	-	
3.3	Evaluate WPs	WIGOS PO	II. 2011	
3.4	Formulate recommendations based on lessons learned	EC-WG	II. 2011	
3.5	Continue development of RRR process for WIGOS and WIS	CBS President	-	
4.	**Report to Cg-XVI**	Chair, EC-WG WIGOS PO		
4.1	Prepare the report on Integration for submission to Cg-XVI by the President of WMO	Chair, EC-WG	II. 2011	
4.2	Prepare the WIGOS-related document for Cg-XVI	WIGOS PO	II. 2011	
4.3	Prepare the WIS-related document for Cg-XVI	WIS PO	II. 2011	

Notes:
1) EC-WG: EC WG on WIGOS and WIS
2) ICG-WIS: Inter-Commission Coordination Group on WIS
3) SG-WIGOS: Subgroup on WIGOS
4) WIGOS PO: WIGOS Planning Office
5) WIS PO: WIS Project Office

[1)] Review of CONOPS for specific items driven by decisions of EC-LXII (see Item 11- paragraph 11.2)

Annex to paragraph 10.1

REPORT ON THE INTEGRATION OF THE WMO OBSERVING SYSTEMS

(Layout)

1. Background
2. Governance
3. Strategic Roadmap
4. WIGOS Projects and Lessons Learned
    - *Pilot Projects*
    - *Demonstration Projects*
5. Co-Sponsored Observing Systems
    - *GCOS*
    - *GOOS*
    - *GTOS*
    - *WCRP Observing Components*
6. Global Earth Observation System of Systems (GEOSS)
7. Coordination with WMO Information System (WIS)
8. Rolling Review of Requirements (RRR) Process
9. Technical Regulations
10. WIGOS Development and Implementation Strategy (WDIS)
11. Priority Activities for the Future
    - *Use of Technology Improvements*
    - *Development of the WIGOS Databases*
    - *Quality Management*
    - *Standardization*
    - *Planning, Optimizing and Monitoring of Observing Systems*
    - *Enhanced Coordination with Partner Organizations*
    - *Strengthening Capacity Building*
    - *Better Support to Services Provided by NMHSs*

_____

Note: The highlighted text reflects changes/additions based on the discussion of Doc.10.