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Report of the Second Meeting of the Ad Hoc Scientific and Technical Planning Group for a Global Terrestrial Observing System (GTOS)

16 - 20 January, 1995, Rabat, Morocco

ICSU UNEP FAO UNESCO

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1. INTRODUCTORY ITEMS

Agenda Items 1-2

The second meeting of the Ad hoc Scientific and Technical Planning Group for GTOS was hosted by the Institut Agronomique et Veterinaire Hassan II, Rabat, Morocco. It was attended by 15 members of the Planning Group, representatives of four of the GTOS co-sponsoring organisations (ICSU, UNESCO, UNEP and WMO), representatives of GCOS, NINA and the Scientific Secretariat for the Planning Group, and participants from other institutions of particular relevance to the meeting (Annex I).

The meeting was opened by Dr. David Norse, Chairman of the Ad hoc Scientific and Technical Planning Group for GTOS. Dr. H Narjisse welcomed the 27 participants on behalf of the institute and its Director, Dr. M. Sedrati.

The proposed agenda was adopted (Annex II).

Dr. David Norse summarized the activities of the Planning Group during 1994 and presented the draft proposal for the GTOS plan, "GTOS: Turning a Sound Concept into a Practical Reality", which had been distributed to all participants before the meeting. He emphasized the need to give weight to certain themes within the GTOS plan and indicated a number of issues which should be addressed during the meeting.

2. REPORTS ON 1994 ACTIVITIES OF THE GTOS PLANNING GROUP

Agenda Item 3

Reports were received from the Chairmen of the three Working Groups of GTOS and the GCOS/GTOS Terrestrial Observing Panel and from Drs. J. Innes and I. Bucher-Wallin of the Scientific Secretariat at WSL.

2.1 WG1. Data Management, Access and Harmonization. Chairman: Prof. M. Baumgardner

- Workshop on Harmonization of Environmental Data, Munich, Germany, 7 - 10 June 1994. A Summary Report on this meeting was distributed to all Planning Group members and the representatives of the sponsoring organizations in September 1994
- Workshop on GTOS Data Management, Access and Harmonization, University of Maryland, College Park, Maryland, USA, 2 - 4 November 1994

The full Report of Working Group 1, which has been used as documentation for the draft proposal, was distributed in Rabat.

2.2 WG2. Operational Aspects of GTOS. Chairman: Dr. J.-C. Menaut
A workshop was held at the Norwegian Institute for Nature Research (NINA), Trondheim, Norway, September 12 - 14, 1994. The Report of this meeting was distributed to all Planning Group members and the representatives of the sponsoring organizations in December 1994.

2.3 WG3. National Needs. Chairman. Dr. H. Narjisse
A workshop was held at the Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, Switzerland, September 7 - 9, 1994. The report of this meeting was distributed to all participants of the meeting in November 1994.

The full report of Working Group 3, which has been used as documentation for the Draft Proposal, was distributed to all Planning Group members and the representatives of the sponsoring organizations in December 1994.

2.4 GCOS/GTOS Terrestrial Observation Panel (TOP). Chairman: Prof. J. Townshend

- First meeting of TOP 28 - 30 June 1994 in Washington D.C.
  This meeting considered observational requirements of climate models and requirements to assess climate change impact on ecosystems. An outline and strategy was developed to formulate a comprehensive Terrestrial Observation Plan, which was presented at the meeting of the Joint Scientifical & Technical Committee for GCOS, held in Hamburg, Germany, September 19 - 22, 1994 (JSTC-IV)
- An ad hoc working Group meeting was held 21 - 22 November 1994 at WMO in Geneva to provide a basis for including hydrological requirements in the Plan.

Reports of the meetings in Washington and Hamburg were distributed to all participants of the Rabat meeting in December 1994. The reports contributed to the documentation of the draft proposal.

Prof. J. Townshend presented a supplementary report of the Joint GCOS/GTOS Terrestrial Observation Panel (Annex III)

2.5 Scientific Secretariat

Contributions to the GTOS planning process in 1994 included:

- meeting organization
- an evaluation of the post-UNCED conventions
- preparation of a compendium of networks and long term ecological monitoring programmes as well as on wetland sites relevant to GTOS.
- preparation of a new questionnaire and development of a new relational meta-database (system Oracle) for the documentation and selection of sites to be placed in the GTOS network

3. CONSIDERATION OF THE DRAFT GTOS PLAN

Agenda Item 4

3.1 Reactions of the Co-sponsoring organizations

Statements from each of the co-sponsoring organizations were presented outlining their various reactions or and proposals for amendments to, the Draft GTOS Plan. The main points of each statement are summarized below:

UNEP

UNEP congratulated the Planning Group on the progress of the work and confirmed that GTOS was an ambitious project. It reaffirmed its commitment towards GTOS becoming a fully operational system and one which could, inter alia, provide valuable data input for UNEP assessments such as the Global State of the Environment Report in 2002.

UNEP agreed with the main bulk of the report and looked forward to its completion.

Attention was drawn to the following comments which had emerged during UNEP's internal review of the draft proposal:

- The justification for GTOS needs strengthening, particularly beyond the needs of the scientific community. It is important to avoid the impression, that GTOS is being implemented for its own sake, e.g. that GTOS is a system looking for a user

- The unique character of GTOS and its advantages in comparison with other programmes or systems needs to be emphasised. GTOS must have a global science concept and framework but bottom-up implementation
- The relationship to other ongoing activities needs to be clearly specified to demonstrate coordination and cooperation and building on what already exists, rather than duplication
- The range of outputs and benefits of GTOS, beyond raw data, need to be specified. In particular, the benefits to participating countries need to be emphasized and potential links to development issues and improved decision making and policy setting demonstrated
- The operational structure needs to be more clearly defined
- A cost - benefit balance (as prepared for GCOS and GOOS) would be useful for GTOS
- UNEP believes that it is unrealistic to develop a system with operating costs of US$ 50M per year. By prioritizing and phasing it should be possible to design an affordable alternative.
- A clear definition of the implementation phases (costs, duration, etc.) should be formulated.

UNESCO
UNESCO was satisfied with the GTOS Plan and stated that the draft plan was a good start for the next two years. However, UNESCO had the following remarks:

- The plan shows a tendency to include research as well as the monitoring activities. This aspect should not be over-estimated as the programme is complementary to recently implemented research programmes such as Diversitas and IGBP.
- Links to existing networks, working on regional levels, e.g. ROSELT, need to be established. In that way some of the difficulties which characterise the implementation of terrestrial networks could be reduced.
- The terrestrial part of coastal systems and islands should become a higher priority (in cooperation with GOOS)
- The tasks of GTOS should be limited. It would probably be practical to start with a small part of the programme and expand the activities later.
- The socio-economic factors should not be over-emphasised; it is necessary to avoid GTOS becoming a "political football".
- There should be a balance between over-selling and providing too little information for the potential users
- It is necessary to analyse how GTOS will fit into existing systems
- The costs for GTOS are underestimated rather than overestimated
- A co-sponsor meeting is required in February/March at ICSU in Paris to analyze the costs for GTOS. Some funds would be available from UNESCO after 1995
- The links between the Planning Group and the bureaucracies need to be specified

WMO
WMO largely agreed with the comments of UNEP and UNESCO. In addition the following points should be considered:

- GTOS should be an umbrella organization for national activities: a bottom-up approach after the pattern of e.g. World Weather Watch, which uses a small central group to coordinate national inputs.
- Easy access to data must be guaranteed
- WMO agrees with the other sponsoring organizations in that funds of as much as 50 mio. US$ per year will be difficult to find
- The main task of the Rabat meeting should be to work out a realistic proposal before the meeting of the co-sponsors in February - March 1995

ICSU
ICSU was satisfied with the GTOS plan but would like to have the following points specified:

- There should be a balance between research and the national needs, which is primarily the data collection. ICSU feels that GTOS should not engage too much in research.
- It is necessary to use information from the existing networks and to try to fill the geographic gaps.
- It should not be expected that social scientists will provide much help as they have no tradition in global research. In contrast to many natural science programmes, they often do not have contact to national committees.
- The science for the development of strategies for sustainable development should be considered
- ICSU found the proposed structure too top-heavy. Instead of a very large Steering Committee, a Scientific Group and a Group of Sponsors would be sufficient. It questioned need for Regional Offices.
- The annual costs of 50 mio. US$ are considered to be too high. It should be estimated what has already been spent by other programmes.
- ICSU will pay the sum of US $ 20 000.- for 1995

FAO
As there was no representative of FAO present at the meeting, Dr. D. Norse presented the statement written by W. Sombroek, FAO, Rome.

FAO was pleased with the major attention given to agro-ecosystems, the socio-economic driving forces, and the needs of developing countries. Some comments and suggestions for the improval of the text of the Draft Proposal were listed. This document was copied and distributed during the meeting.

3.2 Views of GCOS and GOOS representatives

GCOS
Dr. T. Spence, Director of the Joint Planning Office for GCOS described recent activities of the Joint Scientifical & Technical Committee and related planning for GCOS. He suggested that GTOS might use a similar structure, supported the clear list of elements to be treated by GTOS and observed that the draft proposal was a reasonable start. He raised the following points:

- The plan proposes more responsibilities than can be served
- The work involved is underestimated
- The "missions" of the participating agencies will be difficult to reconcile
- The needs of the sponsors should be specified

He suggested that attention be given to:

- Establishing a close link among the three observing systems
- Limiting the focus to achievable goals
- Clarifying the contact between GTOS and the research community as well as the operational organizations

GOOS
At the invitation of the Intergovernmental Oceanographic Commission, Dr. T. Spence provided information about the GOOS including the Intergovernmental Committee for GOOS (I-GOOS), the Joint Scientific and Technical Committee for GOOS (J-GOOS) and the GOOS Support office. On their behalf he relayed to the STPG the following offer for coordination between GOOS and GTOS:

- Participation of the Director of the GOOS Support Office in the activities of the GTOS Steering Committee

- Participation of IOC/GOOS experts in the GTOS Data Management Committee
- Regular consultations among the offices of GOOS, GCOS and GTOS on the coordination of activities of common interest.

3.3 Reactions of the Planning Group Plenum

During subsequent discussion the following additional points were made in relation to the draft plan:

3.3.1 The Planning Group liked the concept of the draft proposal in principal, but individual members found that conceptually it was not sufficiently broad.

3.3.2 The following elements should be considered in redrafting the text:

(i) the two parts of the proposal should be better cross-referenced

(ii) existing programmes should be better evaluated regarding their usefulness to GTOS.

(iii) inclusion of an integrated overview of global observations. (covering EOS and other programmes), would be useful

(iv) appropriate references to the post-UNCED Conventions should be included

(v) the contribution to sustainable development should be analysed, and could be specified in terms of Agenda 21

4. WORKING GROUP SESSIONS ON THE DRAFT PLAN

Agenda Item 5

The three GTOS Working Groups met to revisit sections of the draft plan related to their terms of reference, to rework and redraft these sections where necessary, to address unresolved issues and remaining gaps, and to come up with sharper estimates of costs and a phased approach to implementation. In addition, a joint Working Group of WG1 and WG3 (WG4) was constituted under the Chairmanship of Prof. M. Baumgardner to discuss the structure, costs and phasing of Regional Centres and a Sub-group (WG5), chaired by Dr. J. Townshend, was set up to deal with the role of space observations in GTOS.

Reports of these Working Groups are given in the following Annexes:

WG1:	ANNEX IV
WG2:	ANNEX V
WG3:	ANNEX VI
WG4:	ANNEX VII
WG5:	ANNEX VIII

5. PLENARY DISCUSSIONS

Agenda Items 4.3 and 6

Plenary discussions were held following presentations from within meeting Working Groups and on a range of other GTOS issues. The most important points of these discussions are listed below:

5.1 Data management, access and harmonization

(i) The danger of collapse of the existing networks was emphasized. This problem can be solved by internationally recognized data management systems such as SOTER, because this system is operational, handles data at different spatial scales and is thoroughly tested and implemented at national level in developing countries in Latin America, Africa and Asia.

(ii) It was seen as important to have interpretative software

(iii) The importance of having primary, not pretreated, data was emphasized

(iv) There was discussion in the Plenum as to whether the responsibility for setting standards and harmonization guidelines should rest with Regional Centres. It was agreed that a single set of standards should be applied throughout GTOS.

5.2 Operational Aspects

(i) Issues

- The option of dealing separately with managed and natural ecosystems was discussed but it was concluded that the distinction would cause problems as the borders are unclear. Also there are very few real natural ecosystems left. It was suggested that GTOS should concentrate on some specific and sensitive ecosystems and not try to cover the whole range.
- The suggestion of WG2.1 to include water resources management as an additional GTOS issue was accepted.

(ii) Variables

- It was proposed that GTOS should concentrate on variables which are suitable to detect changes and which are globally relevant.
- It was also proposed that large-scale key processes ,such as those relating to the water balance, should be included in the list of variables as these would be of wide interest and applicability to global change.

(iii) Sampling strategy, site levels

- It was queried whether the 6 levels of sampling could cover national, regional and global data needs.
- It was agreed that GTOS should work to derive a globally consistent "stratification driver" with a defined classification of sites, which should be unbiased and statistically significant. It was doubted if one system of classification would be enough to cover all site levels.
- It was also suggested that variables must be measured at different scales, because it would make a great difference if they are monitored at plot or at landscape scale.
- The lack of data specification for existing models and of definition of minimum data sets were recognised as a problem. The Fontainebleau meeting worked to fill these gaps, but more clarification was needed.
- Further it was felt that a description of how the data will be generated and the flow of data are still needed. This information will be necessary to generate the manuals for sampling and analyses.

5.3 GTOS Structure

It was argued that, even if it would be desirable to have a bottom-up approach, there are elements of top-down structure, which can not be avoided, such as the linking of existing networks. The issues input, on the other hand, could be suggested by national institutions as a bottom-up approach.

5.3.1 Lead agency

The necessity of having a lead agency for GTOS was discussed. Whereas the representatives of UNEP and UNESCO saw the benefit of a lead agency in helping to sell GTOS and maintain its continuity some of the Planning Group members doubted the need for such a structure. No agreement was reached as to whether GTOS should have a lead agency and if so, where GTOS should be located.

5.3.2 Regional Structure

(i) The PG emphasized that regional focal points are critical for the successful achievement of GTOS goals, but recognized the need for a flexible approach in choosing the most adapted structure depending on regional specificities.

(ii) Agricultural (including Forestry) Research Centres would be able to provide equipment and training and could be useful as Regional Centres

(iii) The suggestion of Joint Working Group 1 and 3 that the PG Chairman should contact a number of appropriate institutions and get their reaction to the possibility of playing a catalysing role in their respective country, and their future participation in GTOS was positively received. It was also felt desirable to include NGOs in the process.

5.3.3 National Structure

(i) Capacity building at national level would not necessarily need to be carried out through Regional Centres

(ii) The necessity of having National Committees was questioned.

5.3.4 International Secretariat

The International Secretariat was considered to have too many responsibilities in comparison to other organisational components

5.4 Socio-economic Drivers

The lack of reference to socio-economic drivers in the current draft proposal was criticized, but it was also felt that GTOS has sufficient other tasks to deal with. Building theme interfaces with socioeconomic scientists could solve the problem. It would be sufficient to know the impact of humans on ecosystems and what humans need from the ecosystem. The question of "why?" would have to be answered by other programmes. The first priority will be to have georeferenced data, which should be primary data (not indicators), that refer to socioeconomics as well as to biogeochemistry. Socio-economic processes and structures should both be considered.

5.5 Monitoring versus Research

Whereas the co-sponsoring organizations in general found that research should only be used to develop the monitoring systems, but should not be a component of GTOS, the Planning Group was against the tendency of the sponsors to separate monitoring and research.

5.6 Funding

(i) The overall costs indicated in the Draft Proposal were considered to be underestimated. One useful approach might be to estimate how much could be achieved with a certain amount of funds.

(ii) Costs for managing sites were made on the basis of
- One coordinator for every 10 intensively monitored sites
- One coordinator for every 100 less intensively monitored sites

(iii) 80-90% of the costs for the programme were estimated to rest at the national level, 10-20% at the regional level and ca. 2% globally.

(iv) It was also expected that 80% of the total effort would be spent on ground observations.

6. FUTURE PLANNING ACTIVITIES AND FINALIZATION OF THE DRAFT PLAN

Agenda Items 6.2 and 6.3

6.1 Future Activities

The most urgent future planning activities were defined as follows:

- Set up an agenda for further activities
- Define key questions and variables relating to the GTOS global change and sustainable development issues already defined
- Define sampling strategies
- Review existing activities and identify gaps
- Prioritize gap filling and enhancement
- develop a phased implementation scheme

6.2 Time Table

Dr. D. Norse presented a time table for the finalization process (Annex IX). The following points were raised in connection with the proposed time table:

(i) It was felt that more time would be required for the review. To save time it was suggested that WG2 activities should be continued in parallel subgroups.

(ii) After having agreed the key issues, the priority of WG2 would now be to address the key questions and variables. It was considered to be necessary to buy in skills on the form of a sub-contract.

(iii) Dr. J. Innes stressed that choosing site criteria was not a function of the Scientific Secretariat. Dr. D. Norse proposed that WG2 would provide WSL with criteria for site screening.

(iv) If funds are available a Plenary meeting could be held in September 1995.

(v) UNESCO stated the need for a broad review and that an interim document may be required.

6.3 Final Report Structure

Dr. D. Norse presented a proposal for the final report structure (ANNEX X).

ANNEX I

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GTOS Planning Group Meeting
16-20 January 1995, Rabat, Morocco

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ANNEX II

AGENDA

MONDAY 16 JANUARY

14.30 - 18.00

1. OPENING SESSION

   - Welcome addresses: Dr. D.Norse, Chairman of the GTOS Planning Group and Dr. H. Narjisse, Institut Agronomique et Veterinaire Hassan II

   1.1 Approval of meeting agenda
   1.2 Conduct of the meeting

2. CHAIRMAN'S REPORT

3. WORKING GROUP REPORTS

3.1	Data Management, Access & Harmonization:	M.Baumgardner
3.2	Operational Aspects:	J-C.Menaut
3.3	National Needs:	H.Narjisse
3.4	GCOS/GTOS Terrestrial Observation Panel:	T. Spence and J.Townshend
3.5	GTOS/WSL Scientific Secretariat:	J.L.Innes and I.Bucher-Wallin

TUESDAY, 17 JANUARY

09.00 - 10.30

4. CONSIDERATION OF THE DRAFT GTOS PLAN

   4.1 Reactions of the co-sponsors
   4.2 Views of GCOS and GOOS representatives

11.00 - 17.00

   4.3 Roundtable discussion

17.00 - 18.00

   4.4 Preliminary recommendations for re-drafting; Establishment of working groups

WEDNESDAY, 18 JANUARY

5. WORKING GROUP SESSIONS ON THE DRAFT PLAN

THURSDAY, 19 JANUARY

Continuation of working group meetings

FRIDAY, 20 JANUARY

09.00 - 12.30

6. FINAL PLENARY

   6.1 Reports of working groups

   6.2 Finalisation of draft plan

   6.3 Other future activities

7. ANY OTHER BUSINESS

ANNEX III

SUPPLEMENTARY REPORT OF THE JOINT GCOS/GTOS TERRESTRIAL OBSERVATION PANEL PRESENTED AT RABAT MOROCCO, JANUARY 1995.

John Townshend (Chair TOP)

1. INTRODUCTION

A full report of the TOP has been published and the following is supplementary to the full details presented in this report.

In the first meeting there was not time to consider all topics potentially falling within the remit of the TOP. Specifically we did not consider:

* hydrology comprehensively
* the cryosphere comprehensively
* biodiversity/pollution/socio-economic phenomena

It is unclear at this stage whether the items in the latter category should be part of TOP's remit. We believe that the first two certainly do deserve more comprehensive consideration.

2. SPACE OBSERVATIONS

The current document presented to the Rabat meeting places relatively little emphasis on space observations. These deserve far greater emphasis from the point of view of the TOP.

2.1 Types of space observations.

- High spat. res. optical
- Active microwave
- Coarse resolution polar orbiters
- Geostationery satellites.
- Data to improve global topographic data base.

2.2 Scaling up/Scaling down.

- Space observations need to be recognized as having importance not only for scaling up surface observations to global/regional scales to assist modeling, but are also needed for scaling down from coarse scale models so we can better assess local impacts.

2.3 GTOS Roles with respect to space observations

- GTOS needs to play a role in ensuring that space observations better meet the needs of the terrestrial community.
- GTOS can play a role not only at the international level through such bodies as CEOS but can also assist substantially at regional and national levels through improvements in the quality of data acquisitions in terms of suitability, timeliness and pricing

Other GTOS roles

- Objective assessment of needs and deficiencies
- Improving data-definition - N.B. Geolocation
- Specifying meta data
- Influence costs and delivery systems
- Work with CEOS and national agencies and work collaboratively

2.4 Role of space observations for natural resources

- land cover/L.U./vegetation properties (strong contribution)
- water bodies/snow cover (strong contribution)
- soils and regolith mapping (modest contribution in heavily vegetated areas)
- completion of global topographic data base (strong contribution).
- locating ground sampling (strong contribution)

2.5 Role of space observations for pollution and toxicity

Generally only a modest contribution to be anticipated currently from space observations with a number of notable exceptions including aerosol sources,location of depleted ozone levels. If this topic were widened to include health more generally then space observations could contribute substantially to epidemiology.

2.6 Role of space observations for loss of biodiversity

- Habitat and ecosystem biodiversity - fragmentation (strong contribution)
- other types of biodiversity (much smaller contribution)
- Assisting field sampling (strong contribution)

2.7 Role of space observations for climate change

This formed a major part of the considerations of the first meeting of the GCOS/GTOS TOP. In all the following areas the contribution of space observations with respect to the land is either high or potentially high.

- Closing carbon budget
- Parameterization of GCMs
- Impacts on L.U./Land Cover
- Response models
- Biogeochemistry
- NPP
- Ecological response
- Hydrological cycle

2.8 Role of space observations for land degradation/improvement

- Changes - soil erosion and salinization (potentially high but changes are often small in area indicating the need for very high spatial resolution sensing).
- Land cover/land use (much of the evidence of land degradation and improvement can only be obtained indirectly on the basis of surface observations: those of land cover/land use are especially important).

2.9 Areas for additional "research"

- Many new sensors soon will be providing data - disseminate information at regional and national needs
- Radars - biomass and terrain/regolith
- Hyperspectral Remote Sensing for biochemistry
- Commercial very high resolution (c. 3m.) systems

2.10 Areas where improvements are needed in the processing chain.

- Meta-data information systems
- Improved acquisition strategies for high res. data
- More user-friendly products
- Changes in price structures
- Improved geolocation

2.11 Standing Space Panel
In view of the importance of space observations GTOS should consider having a standing space panel similar to that of GCOS.

3. Hydrology

An ad hoc meeting was held in WMO in November 1994 related to the role WHYCOS. A separate report of this has been prepared and distributed.

4. TOP Next meeting

The TOP is scheduled to have its second meeting in April 1995 in London, U.K.

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ANNEX IV

Working Group I

GTOS Relationship to GCOS and GOOS

There is strong endorsement for close interaction and collaboration among GTOS, GCOS, AND GOOS. Each of these programs is still in the definition state of structure, organization, data management and harmonization. Because of overlapping of data needs, it is recommended that conceptually the three global observing systems have a common, shared, distributed database consisting of many layers and mutually accessible by data/information users of the three programs. Steps have been taken to have cross-representation in the planning/coordinating groups of the three Gs so that in planning and development every effort is made to follow common data management, harmonization and distribution practices.

Data Management Issues

It is crucial that GTOS data management, access, and harmonization issues be coordinated with issues related to national data/information needs (WG3) and with organizational and structural plans (WG2) for GTOS. Until there is a clear designation of a) the terrestrial ecosystem parameters which are to be observed, measured, and documented and b) the terrestrial sampling strategies to be used, it is extremely difficult to develop detailed strategies for data management and harmonization.

It is important that flexibility and the capability to alter structure, organization and strategies be built into the system. As GTOS evolves into an operational program, it is inevitable that change will be necessary. However, there are a number of conceptual ideas on which there is general agreement.

1 GTOS should be given "global" coordination by a manager and steering board.

2 The steering board should receive guidance from a technical advisory group.

3 A tri-level network will consist of an international GTOS secretariat, regional centres, and national teams. Basic responsibilities of each level in this network have been suggested by Working Group 2.

4 Regional centres should, wherever possible, be linked to existing, financially secure institutions.

5 Collaborating national centres/agencies should be encouraged to collect and analyze GTOS-related data whenever possible. The raw data set will reside with the collectors of those data but will be shared and distributed through the GTOS distribution system.

Role of Space Observations in GTOS

Another dimension which must be addressed in GTOS data management, access, and harmonization is the processing, analysis and integration of environmental data derived from the broad array of aerospace sensors. Aerial and space observations will form an important component of GTOS, GCOS, and GOOS. The importance of space observations relates to the comprehensive overview they provide and their potential for repetitive viewing of an area which allows for environmental change detection.

One of the most significant features of space observations is the potential for scaling up of local site observations and the scaling down of coarse resolution model predictions to assess local impacts. It is anticipated that as plans for GTOS develop, GTOS requirements will have an increasingly important impact on the character of data sets derived from space observations. GTOS will also have an important role in communicating to regional and national user the availability and potential of space observations to meet their needs.

ANNEX V

Working Group II: OPERATIONAL ASPECTS

1 Coverage of this report

Part A , written and edited by Erik Framstad, covers the full WG2 session chaired by J -C Menaut, as well as the session of subgroup WG2.2 chaired by R Scholes. Part B covers the WG 2.1 Session, chaired by O.W. Heal. The report was written by members of this subgroup and synthesized and edited by O.W. Heal.

2 Participants

WG2.1: Beran, Bucher-Wallin, Heal (chair), Hirsch, Kibby
WG2.2: Framstad, Innes, Menaut, Scholes (chair), Solomon, Cheatle, Lasserre, Miller, Norse, Wallen participated part time in WG2 or subgroup discussions

PART A.

3 WG2: Deliberations and specified tasks

3.1 List of topics for WG2
The following points were identified as important to cover by WG2 in Rabat:

- main points of clarification and revision in WG2 report from Trondheim, with emphasis on relevant input to the final GTOS report
- discussion of main gaps for WG2 identified in Trondheim (cf WG2 report, p 20)
- review of major variables addressing the issues and tying these to the sampling strategies at sites
- phasing of implementation (cf WG2 report, p 19)

3.2 Revision points of WG2 Trondheim report
Issues, problems and variables (cf WG2 report, p 2-3)

- each of the identified issues for GTOS should be written out in short paragraphs
- within the major issues, the important questions and problems for GTOS must be identified

GTOS users and products (cf WG2 report, p 4-6)

- section on users and products/services should be redrafted to be more "collective" in terms of users and more realistic in description of potential products
- NGOs must be included as a separate category of users
- examples of products available in the short term must be given
- GTOS must have a realistic assessment of how it can provide for the needs of local users in the short term

GTOS unique features and selection of sites and variables

- what makes GTOS unique is its focus on 'long term integrative' measurements covering a 'global' spatial extent; we should focus on the implications of these characteristics for the process: issues - major (GTOS-relevant) problems - variables - sampling strategy

GTOS must build on relevant existing monitoring activities (programs,networks); a review of current activities must be done to identify possible building blocks for GTOS and gaps which need to be filled by GTOS; this review should be conducted very early in the implementation of GTOS

GTOS must both draw on and co-ordinate existing activities, but also create something new (cf long term, integrative, global)

Sampling and site selection

- the ideal model for the sampling strategy (particularly the level with a high number of systematically placed, low intensity sites) appears to be problematic in terms of number of sites, political constraints on their placement, the costs and the lack of perceived user relevance for nations; arguments for this model need to be presented, and implementation based on phased approaches and bottom-up participation must be developed
- the two models of a hierarchical sampling structure (i.e., the GCOS/GTOS TOP 4-level hierarchy and the WG2 model) need to be reconciled and clarified

How much research in GTOS?

- this point is adequately covered in the WG2 report (p 13-14)

3.3 Filling in gaps identified in Trondheim meeting

Prioritizing variables to monitor

- variables should not be prioritized freely in the sense of presenting a list of variables where one will pick variables based on individual variable priorities; values for several variables may only provide insight and meaning if they are coupled to measurements of variables for related processes; hence, it may be necessary to measure a minimum number of variables for the various major problems identified and at each level of the sampling hierarchy
- this task should therefore be reformulated to specify the minimum set of variables required for the various major problems, at each level of the sampling hierarchy

Biodiversity

- strategies for biodiversity monitoring need to take account of the specific requirements of the Biodiversity Convention they should also draw on the experiences of other activities in this field (e.g., Diversitas, Smithsonian, WSL)

Socio-economic variables

- these variables are very important drivers for many of the GTOS-relevant problems; however, GTOS should not become a major "socio-economic monitoring program". GTOS needs to focus on a few key socio-economic parameters for inclusion in its system
- the geographical reference for socio-economic variables may present a problem
- selection of the relevant variables must await input from relevant experts during the first half of 1995

Sampling requirements for "special features"

- freshwater systems, coast lines, hotspots and similar systems of linear or point form must have their sampling strategies assessed; some kind of linear or point-based stratified sampling, parallel to systems of wider areal extent, may be appropriate, but specialists on these systems may need to be consulted

Review of existing networks and programs

- the current procedure to assemble information on existing networks and monitoring programs set up by the GTOS Secretariat is adequate, but reviewing this information will be demanding and time consuming

- an expert may be commissioned to perform this review during the first half of 1995
- the GTOS Planning Group should specify clearly the requirements for potential sites, programs and networks to be included in GTOS

Clarification of the structure of GTOS

- this will essentially be left to post-meeting consultations
- the following points may require revision or clarification: (Note: these points were not explicitly discussed in the WG2 sessions):
  - the function of the Steering Committee (advisory or operational executive role?)
  - the extent of national representation in GTOS and ways of securing such representation
  - ways of formalized contact and co-ordination with GCOS and GOOS
  - role and establishment procedures for regional centres

3.4 Specific tasks identified

The 5 issues for GTOS

- description of each of the 5 issues (natural resource management, pollution and toxicity, biodiversity, global change, land degradation) in a short paragraph
- identification of the specific problems for each of these issues that GTOS should address;
- suggest what kind of variables and sampling schemes to use for these specific problems; responsible: WG2.1 chaired by Heal (reported separately)

GTOS users and products and services

- redrafting of paragraph identifying the possible users of GTOS (including NGOs) and potential, but realistic, products and services which GTOS could provide;
- treatment should be "synthetic" rather than giving great detail for each user group;
- responsible: Hirsch (reported separately)

GTOS characteristics and their implications

- description of the special characteristics of GTOS (integrative, global, long term)
- the implications of these characteristics for the selection of specific problems, variables, and sampling strategies
- responsible: WG2.2 chaired by Scholes (cf sect. 4 below)

Selection criteria for sites

- development of specific selection criteria for sites, both for assessment of existing sites for inclusion into the GTOS framework and for specification of the desirable properties for new sites;
- needs input from points 1 and 3 above; not started at this meeting

Model for phased implementation

- description of a generic model for phased implementation of GTOS;
- a specific description of the implementation must await clarification of several points above
- responsible: Innes **(Table 1)**

Table 1. GTOS Implementation Phases

	12/95	12/96	12/97	12/98	12/99	12/00	...
Approval of proposal	*						
Funding	*						
Identification of lead agency	*						
GOS database management coordination	*						
Establishment of secretariat	*						
GTOS advertising	************************************						
Brochure	*			*		*	
Newsletter	* *	* *	* *	* *	* *	* *	*
Mainstream publication(s)		*					
CD Meta data	*	*	*	*	*	*	*
Generation of stratification surfaces (Topo, Landscapes, Land cover)	****						
Definition of responsibilities:							
site data		*					
meta data	*						
added value data		*					
Establishment of steering committee	*						
Establishment of scientific and technical committee	*						
Selection of sites (first round)	*						
Monitoring Institution identification	**						
Upgrading to GTOS standard	**						
Training of initial operators	**						
Integration of existing networks	**************						
Annual/bi-annual site managers' meeting	*		*		*		*
Nomination of GTOS data centres			***				
Arrangements for archiving GTOS data		***					

	12/95 12/96 12/97 12/98 12/99 12/00 ....
Pilot phase	*************************
Testing of methodology	**** ******
Development of:	
Manuals	********
Procedures	*****
Standards	***
Development of QA/QC procedures	********
Product marketing	***********************************
Identification of gaps in plot network	***
Development and testing of training materials	******
Develop external Internet capability	*****
Further Institution identification	***
Capacity building	************
Training of regional groups	************
Establishment of supplementary plots	*******
Establishment of representative network	********
Establishment of remote sensing network	********
Added value work	***************

Sampling strategies for special features
- description of possible sampling strategies for special natural features such as freshwaters, coast lines, hot spots etc which may not be well represented by standard approaches for features of wide areal extent;
- to be developed later, with assistance from relevant specialists

Socio-economic variables
- description of the level of integration for socio-economic variables in GTOS;
- to be developed later, with assistance from relevant experts

4 WG2.2: GTOS characteristics and their implications

4.1 The unique characteristics of GTOS

The land observations within GTOS are aimed primarily at documenting phenomena which are 'global' in their spatial extent, 'integrative' in nature, and 'long-term' in temporal scale. These three features separate GTOS from other such programs and generate several implications for sampling. However, it is the environmental change phenomena themselves, not necessarily the corresponding observations, which possess these three properties.

Global spatial extent

The GTOS remit requires observations of environmental phenomena that are of global extent. These large scale processes must be measured globally. For example, the documentation of the global carbon cycle requires measurements of carbon cycling between atmosphere and land in all places, and not just from, for example, one country. The samples used for these measurements must be identified by site (geo-referenced) and representative of the ecological systems present in the area. A large number of samples is therefore required, and they should be taken from a systematic network, particularly if spatial variability is known to be high. At selected sites, the observations must be related to more intensive measurements, so that a hierarchy of measurements is achieved, ranging from extensive to intensive. Such a process means that it is not necessary to measure everything everywhere but, at the same time, it permits the assessment of the gene-population-species-ecosystem hierarchy.

Integrative phenomena

The nature of the environmental changes of interest to GTOS result from complex, interacting forces and responses. These forces and responses are poorly understood when examined in isolation; instead a systems approach is advocated whereby parallel assessments of a range of phenomena and samples generate a whole which is more than the sum of the individual parts. 'What' change is occurring is only half of the question; the other half is to determine 'why' the change is occurring. Sampling must also result in scaleable observations. Thus, the samples must be multiple and integrative, consisting of a complex and sometimes large set of variables which form the minimum data necessary to document the phenomena that are changing together with the causes of those changes. Because many aspects of the changes are related in space and time, shared observation sites become not only logical but also, because of shared logistics, more cost effective.

Long-term temporal scale

GTOS is intended to detect and document environmental change phenomena over long time periods. In addition, many of these phenomena require long-term observations to reveal their patterns. We understand "long-term" to be greater than the typical five-year research project cycle, and may exceed a human generation. The results of these long-term observations are relevant to policy decisions, that is, they are aimed at providing decision-makers with relevant and relatively definitive syntheses concerning slowly-developing but critical interactions between human activity and the health of the globe's living systems. The sampling program must be sufficient to reveal trends in slow and/or variable processes, enabling the separation of any true trends from the random variation that surrounds all environmental data. The sampling therefore must be repeated and the date and time of the sampling must be known so as to allow comparisons through time. Repeated comparable measures require consistency in the sampling, which implies that the methods used are known and documented, that the accuracy of the measurements is known and that the measurements are based on careful calibration between sampling. Sites with a known history are particularly useful and preferable (when all other factors are equal).

Key words for these characteristics are:

global
- geo-referenced
- large scale processes
- comprehensive
- representative
  * unbiased sampling
  * large number of observations
  * stratification

integrative
- systems paradigm
  * why and what
  * multiple and interactive
  * shared sites
  * covariates
  * minimum data sets
- scaleable
- synergy (1+1 = >2)
- cost efficiency and shared logistics

long-term
- time-stamped
- long duration
  * research project, human generation
  * policy relevant
  * reveal trends in "slow"/variable processes
- repeated measures
- consistent methodology
  * calibration
  * known accuracy
* documented methodology
  * archived data (metadata, methodology info, actual observations)
- sites with history

4.2 Implications for the sampling strategy

The basic model

The sampling strategy should provide 1) global and representative spatial coverage, 2) the integration of measurements made at different levels of observational intensity and for various important processes, and 3) long-term measurements of key variables for these processes. Inclusion of sites in various countries should be based on mutual benefits to the overall GTOS objectives and national needs. The sites should be structured hierarchically in a manner which embraces and extends the main ideas in the four-level hierarchical framework suggested by the GCOS/GTOS Terrestrial Observation Panel (**cf.Figure 1**).

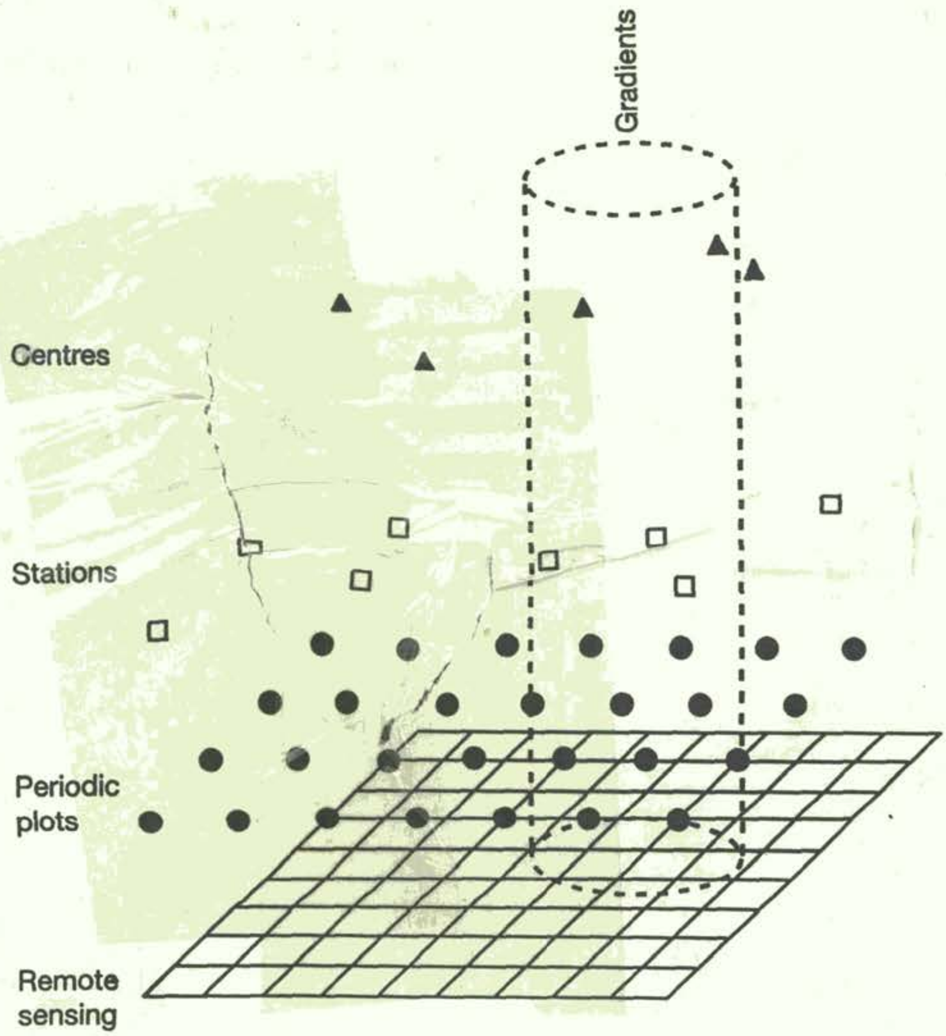

Figure 1: Relationship between sites in the GTOS sampling hierarchy proposed by Working Group 2

Site selection should be governed by the following requirements:

- the hierarchy should be built primarily on existing experiments, research sites, bioreserves, and monitoring networks to which these belong
- the hierarchy should provide gradients of increasing spatial representivity, range of variables, technological complexity and frequency of measurements;
- at the highest (most intensively observed) level, for relatively few 'centres', there needs to be continuous, comprehensive measurements of variables for most important processes to achieve an integrated view of environmental changes;
- at a greater number of representative, permanently staffed 'stations' a set of variables for key processes should be monitored at regular intervals;
- at the lowest (least intensively observed) level, a large number of plots should be distributed to achieve the widest possible, minimally biased global coverage, where only a minimum set of key variables should be measured at rather infrequent intervals (e.g., every 5 years);
- the sampling strategy should be integrative in that variables measured at one level should be nested within the set of variables measured at the levels above it; a 'minimum set of variables' will therefore have to be specified for sites at each level;
- a selection of the sites at all levels should be placed in 'transects' along a few major ecological gradients so as to achieve spatial integration between the sites, validate scaling approaches, detect and understand spatial processes, and monitor changes over thresholds and ecotones.

Data from remote sensing images will be collected for key variables, in order to achieve true global coverage:

- high resolution data for slowly changing features such as land cover may only have to be collected at infrequent intervals (5-10 years);
- data pertaining to more rapid changes must be collected at higher frequencies but can be composed at lower resolution;
- the role of GTOS in this particular area may be primarily to catalyse and co-ordinate remote sensing activities and to recommend sampling standards, areal coverage and sampling frequencies, so as to provide estimates of global and national land cover and land use change at appropriate intervals.

Comments

The essence of GTOS is to integrate information over the different levels of the hierarchy of sample sites and, by helping to fill in gaps in the networks of existing sites, facilitate the flow of information between the various sites and levels. In addition, it should help to harmonize the sampling. For each of the site levels, the scientific and management problems which will be addressed and the products which will result should be identified.

Sampling at the plot level (i.e., with the widest spatial coverage, but at the lowest intensity) is needed to achieve global and representative measures of a minimum set of key variables. This can be achieved by systematic, grid sampling where existing knowledge is poor. Some form of stratified random sampling will likely be more effective, both in operational/cost terms and with respect to problem focus. The important point to make here is that sampling at this level should be as unbiased as possible in order to be truly representative.

The specifications of the minimum sampling requirements at each level should not address methodology, but rather the variables, their units of measurement, and the accuracy of those measurements.

5 Remaining issues for WG2

1 The major problems - their relevant variables and sampling regimes

The remaining high-priority tasks for WG2 (and the PG) is to
- specify the actual major problems to be addressed by GTOS
- identify the minimum set of key variables to be measured for these problems at each of the sampling levels (and any other necessary minimum requirements)
- present credible and specific products which will result and their contribution to the knowledge and solution of the major problems

The need for clarification of major problems and selection of actual variables and sampling regimes includes the questions of biodiversity, fresh waters and other "non-areal" habitats, pollution, and socio-economics.

The contribution of each aspect of the sampling strategy in meeting the GTOS objectives must be reviewed after the selection of major problems and their relevant variables. Modification of certain aspects of the sampling strategy may then be needed.

2 Implementation

The second priority task is to develop a concrete, phased implementation plan for GTOS. This should be based on the generic plan presented by John Innes. It should take fully into account the actual approaches selected to address the major problems.

3 Organizational aspects

Several organizational aspects of GTOS still remain to be clarified. Some of these may more easily be tackled after the major problems are decided. Others should probably be formulated as more flexible and optional arrangements (e.g. the regional centres). A minimum, necessary structure for GTOS to get started seems most essential at this stage. There should be possibilities for adaptive development of the structure as GTOS matures.

PART B.

Working Group 2.1: GLOBAL ISSUES OF RELEVANCE TO GTOS.

CONCLUSIONS

1. The major global concerns focus on the key driving forces of Climate Change, Pollution and Natural Resource Management, and on their consequences and feedbacks. Loss of Biodiversity and Land Degradation are particular current concerns. These concerns represent different facets of the overall issue of Sustainable Development. GTOS, through integrated monitoring of both driving forces and impacts, is designed to contribute to assessment and sustainable use of air, land, water and biotic resources.

2. A common hierarchy of SAMPLING STRATEGIES, ranging from intensive, short-time scale, sophisticated field observations through to comprehensive remote sensing, is applicable to the full range of issues. Many of the VARIABLES required for individual issues are of common interest to all the concerns. For example, measurement of local climate, vegetation composition, soil carbon and nitrogen, and water quality are relevant to all concerns.

3. Sampling along selective GRADIENTS is a particular strategy, valuable in detecting spatial changes in relation to environmental variation. Selection of gradients is likely to be more specific to individual issues than are other sampling strategies.

4. The existence of a structured hierarchy provides a SAMPLING FRAMEWORK which can be used opportunistically for emerging regional or global concerns, with the added benefit of comprehensive background information.

5. The five major issues provide foci for PROGRAMMES or PANELS within GTOS. Whilst using common sampling strategies and variables, these programmes will increase technical strength and, more importantly will provide focussed interpretation of GTOS results in relation to specific issues, users and sponsors.

6. An additional issue of global concern which should be given particular attention and visibility within GTOS is WATER RESOURCE MANAGEMENT.

GLOBAL ISSUES

It is necessary to look behind these issues so as to identify the key underlying questions that GTOS must help to answer, and which should play a major role in finalising recommendations on the types of sites and variables to receive priority in the initial implementation of GTOS.

1. GLOBAL CLIMATE CHANGE

Concerns related to climate change centre on the consequences to natural and managed terrestrial and freshwater ecosystems of altered climatic patterns, sea level rise, and elevated CO_2. Regional, seasonal and interannual variations from the expected trends are also of concern. In addition to the potentially damaging impacts on natural resources and their use, there are concerns about positive feedback effects that may amplify the initial climate change e.g. through enhanced CO_2 and trace gas emissions or through alterations in land cover which affect albedo.

This, essentially global, issue demands a global approach to data collection in terms of coverage and uniformity. Two questions that characterise the range of possibilities that will be addressed through GTOS data are:

- How can we quantify and detect ecosystem change in species composition and their function within earth systems? This question arises directly from the provision of Article 2 of the Climate Convention (FCCC) which expresses the permitted degree of climate change as that which will allow ecosystems to adapt naturally.
- What is the contribution of the terrestrial biosphere to the global carbon budget, which systems contribute most and provide greatest opportunities for sequestration? Failure to balance the budget of anthropogenic carbon has emerged as a major stumbling block to full and unreserved implementation of the FCCC. Resolution of the problem and consideration of potential action will be assisted by precise, quantitative data on the distribution and changes in terrestrial carbon pools and fluxes. Such data will also be beneficial at local level by allowing local contributions and options to be placed in a wider context.

Variables that need to be measured in relation to these issues include land cover, biomass, soil carbon, and associated fluxes of carbon between air, land and water. These measurements, along with others related to ecosystem health, must be made on systems which are representative of the main biomes and agroclimatic zones. There is considerable overlap with the data required for terrestrial systems by GCOS and a range of measurements by remote sensing, as well as both intensive and extensive field observations, is required.

Some comprehensive observations are already being made in relation to the issue of global climate change e.g. on climate and land cover. However, many of the projections lack comprehensive and systematic ground-based data, particularly in relation to long-term change.

2. NATURAL RESOURCE MANAGEMENT

Natural Resource Management (NRM) is the suite of human activities which utilise the land resources of air, soil, water and biota to provide essential goods and services. With the expanding population the demands on these resources is increasing and it is necessary to ensure that their long-term ability to support human demands are maintained i.e. that their use is sustainable. One of the requirements in the pursuit of sustainability is the availability of data on the distribution and quality of the land resources, their current use and ways in which they are changing. This requirement relates to both natural and managed ecosystems because the changes that are occurring include conversion of natural systems, such as forests to agricultural land, the conversion of savannas and grasslands to croplands, the urbanisation of croplands. These simultaneous changes in land use may also be modified by changes in the intensity of land management, such as fertiliser application, grazing regime or felling practice.

Although routine observation of the state and change in land resources is a requirement for wise policy, planning and management practice, there is as yet no comprehensive system available, even in developed countries such as USA. Significant developments have occurred through individual organisations in documenting agricultural land or forests or wetlands or water, but the data are still fragmentary despite the efforts of international agencies such as FAO. There is the additional complication that the interest in sustainability has expanded the range of factors that need to be observed together, in order to improve understanding of cause and effect. The requirement is therefore for an observing system which provides

1. comprehensive information on the distribution and change in land cover and land use

2. detailed information on the type, intensity and change in management practices

3. data on the system products e.g. food, fibre or fuel, in relation to population requirements

4. long-term and extensive information on the state of the basic resources of air, soil, water and biodiversity associated with land use and resource management.

Whilst such an observing system is necessary to provide data on global changes in land resources which provide the major food and other human requirements, it is also essential in order to determine 1) the effects of changes in resource management on the emission of greenhouse gases, surface reflectance and carbon sequestration 2) most importantly, the management options which can provide the essential supply of food and other resources for the local and regional population.

The proposed GTOS strategy combines 1) Remote sensing to provide the complete land cover information which can be translated into major land use categories. The remote sensing will be closely linked with the GCOS program and will also provide the general assessment of change in land cover e.g. of forest area. 2) Field measurements at both extensive and intensive sites. The extensive sampling will be structured to give accurate estimates of global and regional resource characteristics and their change. The more intensive sampling of major sites, which are representative of main ecosystem and land management systems, will give detailed observation of the dynamics of the systems and how they are responding to management and other changes. The ground based sampling will also provide ground truth for the satellite imagery and will enhance it by providing more detailed information which is not detectable from space but can be directly related to land cover e.g. biodiversity. This combination of remote sensing with extensive and intensive field data, plus the measurement of a wide range of variables in an integrated observation system, makes GTOS unique.

A key component of GTOS is in the range of variables measured at the different scales of resolution. The variables are selected to determine the changes in resource properties and products and in the environmental conditions which cause or result from changes in management. The types of variables to be measured are shown in **Table 2**. (to be revised in further discussion).

LEVEL	EMPHASIS	EXAMPLES OF VARIABLES
I	A) Spatial integration	i) dynamics of landscape units ii) transport of soils and nutrients iii) airborne flux measurements iv) planetary boundary layer flux methods
	B) Point measurements	i) trace gases
II	A) Spatial integration	i) population structure ii) continuous tower flux of CO_2, H_2O, energy iii) soil moisture
	B) Point measurements	i) diurnally resolved weather ii) complete radiometry iii) isotopic soil and plant studies
III	A) Stocks and fluxes	i) NPP ii) biomass iii) soil C and N by depth iv) atmospheric deposition
	B) Land use	i) management system (cropping, tillage) ii) fertilizer and irrigation
	C) Spatial integration	i) bio and geo diversity ii) habitat spatial structure
	D) Point measurements	i) leaf chemistry ii) phenology
	E) Daily weather	i) percipitation ii) temperature iii) wind iv) shortwave radiation and PAR
IV	A) Point measurements	i) decadal soil C, N, depth, bulk density
	B) Land use	i) land cover and land use type ii) disturbance
	C) Biodiversity	i) decadal enumeration of vertebrates, invertebrate groups, plants, & microbes ii) decadal status of invading species
	D) Weather	i) interpolated monthly climate from nearest stations

Table 2. Proposed 4-level hierarchical site scheme for a global surface observation system

The proposed observing system will provide systematic, comprehensive and rigorous information on Natural Resource Management. It will depend on the cooperation and experience of the many national and international agencies involved in resource management. However it will provide these agencies with information on the state and change in the natural resources and will provide ongoing information to assess the options for sustained development and for testing the outcome of policy and practice.

3. POLLUTION AND TOXICITY

A wide range of pollutant chemicals are being introduced into the environment. These range from pesticides and organic compounds (dioxins, PCBs, etc.) and radionuclides through to common elements such as nitrogen and sulphur. Sources include local industrial and urban activities and more widely distributed agricultural sources. Some sources are generated continually, others arise from short-term events. Whilst often perceived as local problems, the spatial repetition and cumulative effect, plus crossboundary transport and, in many cases global dispersal, make the issue genuinely global.

Concern is focused on the impacts of pollutants, singly and in combination, on 1) human health e.g. through toxins, increased UVB and effects on physiology and reproduction, 2) animal and plant health, including crop production, accumulation of residues in food chains and change in genetic composition, 3) the quality of soil and water resources, particularly in relation to acidification and eutrophication. An additional concern is the contribution which these pollutants have, directly, as a forcing function in climate change or, indirectly, through changes in land cover.

Many pollutants are monitored in national and international programmes, but there is no existing system designed to detect both changes in pollution load and impacts, particularly in relation to other environmental changes.

GTOS can provide such an integrated programme but it will be relevant mainly to the widespread concerns of acidification and eutrophication because of the specialised nature of analysis of other pollutants. However, the GTOS network will provide a system which can be exploited for monitoring of other pollutants, including widespread sampling in emergencies - a strength of the GTOS strategy.

A network of intensively monitored sites within GTOS is appropriate for the detection of food-chain relationships and population signals. This will be complemented by a more extensive network designed to detect spatially distributed and long-term trends in the state of air, soil, water and biotic resources. Water sampling e.g. in catchments will be particularly useful because it provides an amplified signal of terrestrial change.

4. LOSS OF BIODIVERSITY

Concern over the loss of genetic, species and community or habitat diversity has led to the Convention on Biological Diversity. This requires contracting parties to monitor the components of biological diversity, identify processes and activities which have significant adverse impacts, and organise appropriate data. It is recognized that the causes of loss are many and varied, but primarily through increasing pressures of land use (agriculture, forestry, recreation, urbanisation), often interacting with pollution and climate variation. Monitoring biodiversity and the causes of loss represents a major technical challenge. Analysis of genetic diversity, even in a limited number of selected species, requires intensive screening combined with extensive sampling; a combination which could be incorporated into GTOS. Inventory of species diversity is only possible at a very few sites. However, standardised methods are now available which allow sensitive detection of changes in the species composition of dominant flora and fauna and of selected indicator species. Thus a limited network of sites representative of biomes or zones, combined with systematic sampling for common or indicator species can quantify major changes in species diversity and identify probable causal relationships. Remote sensing will provide information on global patterns of land cover essential to understand habitat fragmentation for example.

5. LAND DEGRADATION

In arid, semi-arid and dry sub-humid areas, the reduction or loss of biological and economic productivity of water-dependent croplands, range, forest and woodland is a major concern. This land degradation, resulting mainly from human activities and climatic variation, is detectable in long-term loss of vegetation, deterioration in soil properties and in soil erosion. The problem, articulated in the Desertification Convention, calls for a "global network of institutions and facilities for the collection, analysis and exchange of information as well as systematic observation at all levels."

Whilst concentrated on a particular climatic zone, the concern with desertification is a global issue because it is repeated around the world, it effects a significant part of the world's population through food and other resource supply, and part of the cause may be attributed to climatic changes generated elsewhere.

In the context of GTOS, changes in the distribution of exposed land surfaces, in erosion and loss of vegetation cover are readily detectable and quantified by remote sensing. A systematic network of field observations can contribute to management by quantifying changes in land use e.g. grazing intensity, climatic and hydrological conditions, thus helping to distinguish causal factors and relating these to changes in vegetation and soil status. Access to extensive databases will help in development plans whilst the use of defined relationships will provide early warning indicators of further land degradation.

WATER RESOURCE MANAGEMENT

As a driver of global environmental concerns, water resource management shares some characteristics with changes in land management in that both are concerned with reducing or eliminating natural fluctuations and with increasing the supply of useful products. Ecological consequences flow from changes in the hydrological regime of rivers, lakes and aquifers and from alteration in water chemistry.

While these are normally regarded as local or regional issues, they are globally repeated and water is a key resource mediating other biogeochemical processes involved in the earth's life support system.

Practical questions of how to improve water supply and minimise environmental damage are mostly answered at the basin scale. However, a global overview of the world's freshwater resources is essential to determine trends, to identify vulnerable areas, to determine priorities and assist countries in developing contingency plans for changing circumstances. Water status, e.g. soil moisture, must also be monitored at the local scale in relation to other environmental concerns of changing climate and biodiversity, whilst at the catchment or aquifer scale aquatic variables are important regional indicators of biogeochemical fluxes.

GTOS will require access to the global database at GRDC and will need additional data on freshwater bodies such as large lakes and wetlands. Internally draining lakes are especially valuable from the viewpoint of regional water balance. Water volumes leaving large rivers e.g. the world's 50 largest rivers, will be required in support of climate studies and for understanding ocean processes. Chemical analyses, especially carbon and phosphorus are also needed for these assessments.

The hydrological cycle is implicated in many other globally significant processes, including cryosphere changes, desertification, salinisation, and wetland drainage. Satellite measurements will assist monitoring of the most significant of these water mediated processes.

ANNEX VI

Working Group III: NATIONAL NEEDS
Rabat, 19 January 1995

Participants: C. Caponi
S. Gupta
P. Lassere
H. Narjisse (Chair)
L. Ogallo
R. Oldeman (Rapporteur 2)
L. Oyebande
C. Stigter (Rapporteur 1)

References:

1. Report of the first meeting of the GTOS National Needs Working Group (Birmensdorf, Switzerland, 7-9 September 1994);
2. Provisional draft of a GTOS plan from National and Regional Perspective (Hamid Narjisse, GTOS Working Group III Chairman)

1. The working group emphasized the crucial need of regional focal points (or regional components) as discussed in reference 2, page 9, 10, 11, although it is recognized that the coordinating role of these regional entities may vary from one region to the other.

2. The working group discussed in more detail the incentives for those participating from developing countries in collecting data for GTOS. The second topic discussed issues related to implementation of activities at national level.

3. INCENTIVES FOR DEVELOPING COUNTRIES (Rapporteur 1)
(It was assumed that free access to global GTOS data and exchange of its products are a sufficient incentive for most if not all participants from developed countries).

3.1 Those participating from the Third World are:
Policy makers and planners in national bodies that will be interested in products derived from the monitored data by added values in many different forms. Data producers at participating national/regional/international Third World based institutes that are involved in GTOS operations. Data users who want themselves to produce value added products from GTOS data that are or become available.

3.2 Needs of policy makers and planners.
Products can be generated as well as absorbed by the two or three levels as distinguished in GTOS (national units; regional networks with one or two focal points; central umbrella or overall secretariat).

3.2.1 Products that can be generated at the lowest level (national units) are initially those that can be easily obtained from simple added value producers, such as statistics or plottings. After gradual training and capacity building, these products can become more complex (e.g. GIS derived products). They should remain geared to specific needs as defined by the national units from needs expressed by the planners/policy makers. Of course, also the complexity and type of products absorbed at this lowest level will change over time, again as a results of better articulated needs and higher training/increased capacity build up for these purposes. Such absorbed products will be (procedures to generate) databases and maps of land degradation; information on land use and land cover; water resources assessment; management strategies to combat a given hazard. These products can also be generated at national level in other countries or at higher (regional and central) GTOS level.

3.2.2 Products at regional level are those that ask in particular for

1) expertise of the respective regional data systems specialist and/or coordinator;
2) data from several nations, for example, those bordering a lake or sharing a river basin or having certain common hazards.

Absorbed products at regional level may come from national levels, if of use to other national levels, or from collections to be made at the central level.

3.2.3 The role of the GTOS Central Umbrella

It is assumed that after an inventory of existing data and products (data with added value), gaps in wanted data and products as defined by GTOS will be identified, the role of GTOS in all this should then be:

1) To facilitate the flow of information.
2) To take care of identified gaps in data or in added value procedures using collected data, which are needed to create highly wanted products.
3) *To finance the closing of such gaps (or organise such financing at all levels) because* these are the incentives for developing nations to participate.

Products for which such gaps may be expected to exist are for example related to solving problems of socio-economic character, problems in such large areas as coastal systems, problems in the field of access to and interpretation of remotely sensed images, and problems of technology transfer in general.

3.3 Needs of Data Producers (Providers)

In relation to the needs of data producers at participating national/regional/international institutes (see 3.1.b) incentives have to come in the form of training in data generating, and in the form of hardware capacity building in their institutes for improved data reception and communication as well as again for data handling and management.

3.4 Needs of Data Users

In relation to the needs of data users, wherever they have been identified within and outside participating institutions (see 3.1.c) incentives have to be in the form of training in creating highly needed added value products using data on GTOS monitored variables, before and after filling the gaps in these data and products. This includes products generated within GTOS at all levels identified, including those generated at higher than national level or collected there from all national levels.

3.5 The role of GTOS with respect to the needs, identified in 3.3 and 3.4 is to finance or to find financing for such training exercises as well as for gaps to be filled in hardware capacity building in communication and electronic equipment for data handling, where gaps prevent participation in GTOS.

4. IMPLEMENTATION OF ACTIVITIES AT NATIONAL LEVEL (Rapporteur 2)

4.1 Principle.

Monitoring of the attributes of the terrestrial system can only be done if baseline data on natural and socio-economic resources are available in a readily accessible, standardized format. This baseline database can be complemented by information derived from remote sensing.

4.2 The implementation at national level should be done in phases. The following steps are suggested:

4.2.1 Selection of a limited number of regions

Regions can be identified on the basis of ecological similarity and common list of priority issues. The following regions are proposed:

- Sudano-Sahelian region
- Mediterranean region
- Central Arid Asia
- Tropical Monsoon Asia
- Equatorial South American lowland
- Andes (High mountain) region
- Central and Eastern Europe

4.2.2 Identification of national institutions within selected regions

Countries within a region should be asked to identify institutions on the basis of active involvement in inventorising natural and socio-economic resources at national level and on the basis of their willingness to play an active role in GTOS. Formation of national teams.

4.2.3 Inventory of available resource materials at national level

Participating institutions should prepare a national inventory of natural and socio-economic materials (maps, reports, databases, etc.). The National teams could also provide a list of national and regional networks, programmes and projects that are operational and relevant to GTOS.

4.2.4 Regional workshop

The national teams should convene at a suitable location in the region. This could be a U.N. regional office, an existing CGIAR institute with a regional mandate or an equivalent institution, who is willing to host the regional workshop. This institute is not necessarily the regional centre (or regional complement). National teams and resource persons will give presentation on the materials as indicated in 4.2.3; discuss methodologies to standardize and harmonize the natural and socio-economic resources; identify potential sites for long-term monitoring; make an inventory of existing hardware capabilities; identify training needs; select a regional focal point.

4.2.5 A national georeferenced database on natural and socio-economic resources

Development of a national georeferenced databases on natural and socio-economic resources according to methodologies approved and endorsed at the regional workshop (4.2.4). A more detailed resource database must be made at selected sites for long term monitoring. Training workshops must be organised and hardware capabilities be installed or upgraded. The regional focal point has a coordinating role and should at this stage be operational. A major task for the regional focal point will be the compilation of a regional georeferenced database on natural and socio-economic resources.

4.2.6 Preparation of Products at national and regional level (see section 3.2.1)

Since regions are selected on the basis of ecological similarity and common list of priority issues, products generated at regional level are also of interest at national level. In addition products of specific national importance can be generated. (In agricultural managed systems the long-term monitoring sites could play an important role in observing the impact of land degradation on agricultural productivity under various land husbandry systems, in monitoring the natural water resources (quality and quantity), in monitoring the pollution of soil and water resources.)

5. Financial implication

5.1 Assumptions:

The regional focal point can be housed in an existing facility. National institutions are willing to provide human capacity for the collection of national resources data. A region consists of 10 developing countries. GTOS will not be involved in providing financial support to do national surveys, or to collect raw data (except those needed for the long term monitoring activities). The first phase can be completed over a period of three years.

5.2.1 Three year budget for the regional focal point (x 1000 US$)

1.	Regional coordinator	450	(three year period)
2.	Information systems specialist	240	(two year period)
3.	Resource persons (consultants)	200	(twelve months)
4.	Regional travel	150	
5.	Hardware capability	200	
6.	Reporting and Communication	140	
	Total	1350	(430K per year)

5.2.2 Three year budget for developing national resources databases (x 1000 US$)

1.	Regional workshops (implementation, midterm, final)	150	(50 for each workshop)
2.	National training workshop	200	(20 for each workshop)
3.	National hardware capability development	600	(60 per country)
4.	National database development (incremental)	600	(60 per country)
5.	Participation in international meetings	100	(10 per country)
	Total	1650	

5.3 A total budget of 1M US Dollars per year is needed for the implementation of activities indicated in section 4 for one region to be accomplished over a three-year period.

ANNEX VII

Working Group I - Working Group III JOINT MEETING ON REGIONAL CENTRES

Participants: M. F. Baumgardner (Chair)
C. Caponi (Rapporteur)
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L. R. Oldeman
L. Oyebande
C. J. Stigter
J. Townshend

There was general agreement on the concept that the regional component is essential for the success of GTOS, so the discussion mainly focused on the appropriate model and phasing.

After reviewing various past experiences (of different organizations in different continents) the group agreed that the actual model for GTOS Regional Centres should grow from the perceived needs of each region, as different models will fit different regions.

To reduce the financial burden, this flexible approach should as much as possible build on what is already existing.

It was also proposed that GTOS should study characteristics that led to success in the past, so as not to repeat the same mistakes of previous experiences.

Comments were made on the need to clarify in the Draft Proposal that regional data management units should be combined with regional centres and not seen as different entities.

Given the agreement that Regional Centres models should be decided in each region by the participating nations, the group logically expanded its discussion to include the item of national participation in GTOS.

It was strongly felt that GTOS should play a catalysing role to get the essential institutions participating at the national level. Furthermore, it was suggested that this bottom-up approach should be explored in the very near future in 2 or 3 regions, where the PG Chairman could contact a number of appropriate institutions and get their reaction to the suggestion of them playing the catalysing role in their respective country, over what time frame they could achieve the first significant results, and whether they needed external funding.

The group felt that this survey could be accomplished in 3 months.

For the implementation phase the group supported the view expressed in the Draft Proposal that in a first stage an approximate number of 6 Regional Centres should be established.

ANNEX VIII

ROLE OF SPACE OBSERVATIONS IN GTOS

1. Introduction

Space observations will form an important component of GTOS. Their importance relates to the comprehensive overview they provide and their potential for repetitive viewing of an area which allows changes in the environment to be readily detected. Some of their most important roles relate to their potential for scaling up of local site observations and the scaling down of coarse resolution model predications to assess local impacts. It is anticipated that as the plans of GTOS develop, GTOS requirements will have an increasingly important impact on the character of data sets derived from space observations. GTOS will also have an important role in communicating to regional and national users the availability and potential of space observations to meet their needs.

In this section we only consider space observations. It also needs to be recognized that aircraft data, for example in the form of conventional aerial photographs and scanner data, are of considerable value in more local surveys including those for intensive ecological observations, but have less relevance to regional and global scales of observation.

2. Contribution of space observations to the main areas of GTOS needs.

The role of space observations is discussed under each of the main headings identified as crucial issues for GTOS in earlier sections:

i) Natural resources
Natural resources management requires inventory and repetitive observation and many components can be observed from space-borne sensors. For example they can provide data on land cover and land use and many characteristics of vegetation canopies. This information can contribute to agricultural, rangeland and forestry surveys as well as the assessment of the impact of humans on remaining more natural systems. The areal extent of water bodies such as lakes can also be observed as can the extent of flooding; snow cover extent, important, for example, in estimating spring runoff for irrigation, can also be mapped. Space observations can also contribute to soil and regolith mapping especially in poorly mapped areas. Where the surface is vegetated, evidence for the latter has to be inferred but in semi-arid areas and areas cleared of vegetation as a result of cropping, surface materials can be directly observed. Completion of improved global topographic data bases will also often be of considerable assistance in deciding on the location of ground sites.

ii) Pollution and toxicity
Space-based observations can provide information on terrestrial sources of aerosols, including point-based sources such as burning in the savannas and tropical forests and for non-point sources such as dust storms. Currently the capability of space-based observations for water quality estimation are essentially non-existent. The observation and tracking of atmospheric pollutants is seen as part of the responsibility of GCOS and coastal pollution will likely be considered by future joint GTOS/GOOS activities. In related health areas, the observation of land cover properties coupled with climate observations has considerable bearing on the epidemiology of many diseases.

iii) Loss of biodiversity
Many aspects of the loss of habitat and ecosystem biodiversity can be directly observed from space including such important indicators as fragmentation. Space based observations can not contribute directly to surveys of species diversity, though information on land cover and terrain characteristics can assist the location of field sampling.

iv) Climate change
The requirements for terrestrial observations have been considered in some depth by the joint GTOS/GCOS Terrestrial Observation Panel in its 1994 report. Many of the recommended observations were space-based. Among the contributions of space-based observations is contributing to the closing of the global carbon cycle through monitoring of changes in the areal extent of forests and rates of regrowth since the latter impacts sequestration. Various space-based land observations are being used in the parameterization of GCMs, including albedo, surface temperature and spectral vegetation indices used to estimate photosynthetic capacity and to estimate the partitioning of energy into sensible and latent heat fluxes. Studies of the impacts of climate change on land cover and land use will also benefit substantially through the use of space observations. Global and regional response models using space data currently under development include those estimating global biogeochemical cycling, net primary productivity, ecological response and the hydrological cycle.

v) Land degradation
Changes in land properties associated with land degradation such as soil erosion and salinization can benefit from space observations though the very local scale of many of the physical changes often limits the value of the data. The indirect evidence of changes in land quality through inference from changes in vegetative land cover is often considerable.

3. The role of GTOS in relation to space-based observations.

GTOS can play a major role in improving the quality of space-based observations to meet its needs. This can be achieved through a number of steps. Firstly there needs to be objective assessment of the deficiencies in observations and an evaluation of the extent to which these needs can be met by space-based observations. There are several ways in which space-based observations can be improved in calibration, geometric registration, removal of unwanted effects for example by atmospheric correction, improvements in acquisition strategies to increase data coverage, creation of higher order products and specification of the characteristics of new sensor systems. One property of particular relevance to GTOS which is often poorly described is geolocation; this is especially important for the detection of change because of the heterogeneity of the land surface. The space agencies and their partners in the ground segment are also important since they are responsible for the format of data products, their meta-data information systems and the operation of delivery systems; they often also determine pricing.

To achieve improvements in the supply of data sets based on space observations, GTOS needs to use its influence as an affiliate member of the Committee of Earth Observation Satellites. It will also need to work bilaterally with individual national and international agencies. GTOS should work closely with the other global observing systems to present a unified statement of needs so far as possible and should also seek to work cooperatively with related organizations such as IGBP-DIS and WCRP, when dealing with the various space agencies and committees. Because of the magnitude of the tasks involved GTOS will have to consider establishing a space observations panel of a form similar to that of GCOS.

GTOS will also have a major role in assisting its regional and national components to understand the contribution of space-observations and in improving the quality of acquisition of data in terms of data suitability, timeliness and pricing.

4. Main types of space-based observations meeting the needs of GTOS.

Five main types of data can be identified, which will contribute most strongly to the needs of GTOS.

i) High spatial resolution optical data.
This category includes data from systems such as Landsat, SPOT, IRS, and MOS, with resolutions of 80m and finer. These data are useful for more detailed surveys, but also increasingly being used for very large area estimations of land cover as in the Landsat Pathfinder project. Use of these data have been limited by high costs though older Landsat data are now available at much lower cost when used for research purposes. An internationally coordinated effort to provide global coverage of high spatial resolution data every 5 years would provide an extremely valuable source of data for land cover and land use data.

ii) Active Microwave data.
Microwave data from space borne radars are becoming available though present sensors such as that on ERS-1 have configurations far from optimal for land applications.

iii) Coarse spatial resolution data from polar-orbiters.
In recent years data from sensors such as the Advanced Very High Resolution Radiometer have become increasingly important for land applications especially for monitoring vegetation dynamics. Their value lies, in particular, in the high frequency of data acquisition, resulting in near global coverage twice daily. These coarse resolution data are also important for estimation of the thermal properties of the surface for estimation of properties such as surface albedo and evapotranspiration. Optical data have been operationally used for estimation of snow cover, though data from passive microwave sensors are replacing this source because of their better capabilities in forested areas. Continuation of the AVHRR 1km project is important for a number of key GTOS objectives.

iv) Data from geostationary satellites.
Geostationary satellite data have the advantage of very high temporal resolution and have been used for estimation of rainfall through cold cloud duration statistics, but remain a somewhat underutilized source of data for terrestrial applications.

v) Data for improving the global topographic data base.
Currently the global topographic data base, especially that available to civilian users, is severely deficient for many applications. Space-borne sensor systems are available which could be used to improve this data base.

5. Systems requiring more research.

Generically GTOS has to be cognizant of the very wide range of new sensors due to be launched in the next few years as part of programs such as ESA's ERS-2, the Vegetation instrument of SPOT IV and the multiple sensors of the international Earth Observing System (EOS) as well as many others. Disseminating information to improve understanding at regional and national levels about how the new data products from these many sensors can contribute to meet regional and national needs will be an important role of GTOS.

New capabilities which still require research to bring them to an operational status include the use of radars for land surface monitoring including the possibility of estimating biomass, the use of radars for soils and regolith investigations, and the potential of hyperspectral sensors for biochemical sensing of canopy properties. At the national level in particular, it is also relevant to note the planned launch of commercial very high spatial resolution systems (sub 5 meter) which will have considerable benefits for topographic mapping.

6. Required improvements in space observations.

A detailed specification of the improvements needed to meet the needs of GTOS is beyond the scope of this document. Nevertheless we can identify a number of areas where improvements can readily be made:

i) Improvements in meta-data information systems. Users often find it extremely time consuming even to find out what space data are available to meet their needs. Improved meta-data and much better meta-data information systems are essential to ameliorate this situation.

ii) Improvements in acquisition strategies especially for fine resolution data systems are needed to improve the coverage and frequency of data collection.

iii) Definition of more-user friendly products better suited to the needs of users working in technical environments with widely varying sophistication.

iv) Changes in pricing structures to make space-based data more widely available.

v) Improved geolocation of data: this will be especially important for change detection and for relating detailed site investigations to space-based observations.

ANNEX IX

FINALIZATION PROCESS: TIME TABLE

22 - 25 January	Redrafting of Basic Proposal
Early February	Co-Sponsors Meeting
6 - 8 February	WHYCOS meeting
February - June	Redrafting Part II
March/April	GTOS/GOOS Meeting
April	GCOS/GTOS TOP Meeting
May	WG2 Meeting
July/August	External Review
September	Final PG Meeting?/ Drafting Session?
October	Final Editing/ Printing
November	Submission to Co-Sponsors

ANNEX X

FINAL REPORT STRUCTURE

		No. of pages
Executive Summary & Recommendations		2
Part I	The Basic Proposal	10 - 15
Part II	The Proposal in Detail - Products and Services - Selection Criteria - Candidate Networks - Candidate Sites - Linking Mechanisms - Gap Filling & Enhancement - Space Observations - Data Base Management & Harmonization - Support to National Bodies - The Coordination Framework	30
Appendices		10