A CEOS Strategy to Support the Global Stocktake of the UNFCCC Paris Agreement

Purpose: This paper sets out a way forward by which CEOS Agencies can coordinate their efforts to support the first and subsequent Global Stocktake (GST) of the 2015 Paris Agreement among Parties to the United Nations Framework Convention on Climate Change (UNFCCC). It covers the specific modalities of the GST and proposes where and how Agencies can support its implementation. Support may be either to the overall assessment of collective progress through the GST, or to individual parties in their transparent reporting as required by the Paris Agreement. Some recommendations are made for future actions, building on the significant efforts to date.

Introduction

Parties to the UNFCCC came together at their annual Conference in 2015 (COP21) in Le Bourget, Paris and signed an accord that recognised the need for action by humanity to reduce the increase in greenhouse gases through a cooperative and constructive framework. This accord is known as the Paris Agreement[1]. The Paris Agreement aims to strengthen the global response to climate change, in the context of sustainable development and efforts to eradicate poverty, through:

- Holding the increase in global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels,
- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas (GHG) development
- Making finance flows consistent with a pathway towards low GHG emissions and climate resilient development.

The Paris Agreement shall also be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities in the light of different national circumstances.

The mechanisms of the agreement were quite different from those considered at previous meetings of the Parties. Individual countries would be required to submit their anthropogenic emission reduction goals as part of their Nationally

[1] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

Determined Contributions (NDCs) every five years. Progress in reducing emissions would be measured through a transparency framework and stocktaking process, with a view to achieving the ambitions of the Agreement set out above.

It is worth noting in passing that there is already a very strong implied requirement for systematic observations in the aims as set out above through the explicit link of future temperature rise to current GHG emissions. This is explored further below in the section referring to the Intergovernmental Panel on Climate Change (IPCC) and its procedures.

The Global Stocktake of the Paris Agreement

Outline of the mechanism

Article 14 of the Paris Agreement (PA) sets out the concept of the Global Stocktake (GST) as a means to evaluate global progress towards the goals of the Agreement. The outcome of the GST will inform the preparation of subsequent NDCs, in order to allow for increased ambition and climate action to achieve the purpose of the Paris Agreement and its long-term goals.

It is worth recalling the text of the relevant paragraphs in Article 14 of the PA concerning the obligations placed on Parties by the GST:

- *".....Parties shall take stock of the implementation of the Paris Agreement to assess collective progress towards achieving the purpose of this Agreement and its long-term goals (referred to as the "global stocktake")..."*
- *".... in a comprehensive manner....considering mitigation, adaptation and means of implementation and support, and in the light of equity and the best available science"*
- *"...in 2023 and every five years thereafter...."*
- *".... (and) shall inform Parties in updating and enhancing, in a nationally determined manner, actions and support in accordance with the relevant provisions of this Agreement....."*

The Paris Agreement itself is an Annex to the Adoption proposal of the COP21 President. The complete text gives considerable detail on the modalities of the implementation of the GST. It also calls upon various Parties, the Secretariat of UNFCCC, its Subsidiary Bodies and some outside bodies, such as IPCC, to undertake specific tasks in its implementation. The Agreement sets up an Ad Hoc Working Group on the Paris Agreement to oversee and guide its implementation and that of the GST.

Foremost among the actions placed on Parties is the establishment of NDCs. Parties are obliged under the Agreement to submit through NDCs their goals to reduce national anthropogenic emissions by 2020 in the first instance and every five years thereafter, regardless of the respective implementation time frames. Each NDC will be required to represent a progressive reduction in anthropogenic emissions compared with the previous one and must reflect the highest ambition

of the country. Less well known is that the NDCs also invite the submission of information on adaptation. In the case of developed countries, further information on finance, technology transfer and capacity building is also required.

Building on the reporting and review processes under the Convention, the Paris Agreement establishes an Enhanced Transparency Framework (ETF) for reporting and review to ensure the transparency of mitigation and adaptation actions and the transparency of support. The Framework is to be implemented in a facilitative, non-intrusive, non-punitive manner, respectful of national sovereignty, and shall avoid placing undue burden on Parties. The overall process is well described in a UNFCCC Reference Manual[2]

Progress of individual countries against their NDCs is reported through the ETF (Article 13 of the PA), mainly through submission of Biennial Transparency Reports (BTRs), the first of which are due by end 2024. All Parties, with some exception for the most vulnerable countries in Small Island Developing States (SIDS) and Least Developed Countries (LDCs), must submit GHG inventories essentially via the BTRs. Industrialized countries still report on GHG inventories every year. Global, collective, progress against the PA ambitions is in turn monitored through the GST and in due course there should be reconciliation between the national reporting and the GST.

These actions together determine whether the world achieves the long-term goals of the PA, to reach global peaking of GHG emissions as soon as possible and to undertake rapid reductions in accordance with the best available science, so as to achieve GHG neutrality by the second half of the 21st century.

The GST will be conducted in three phases, as very well described in the WRI Paris Rulebook:[3]

1. ***Information collection and preparation*** *(2020-2021)*

In this phase the sources of input necessary to conduct the GST will be considered, such as NDCs, scientific studies, country reports (including BTRs) and tailored national submissions, and other information. This will include contributions from the systematic observation community, as discussed at the ad hoc coordination group on Systematic Observations and the GST convened by the UNFCCC Sec. The UNFCCC will prepare multiple synthesis reports to inform the technical assessment.

2. ***Technical assessment*** *(2022 – 2023)*

In this phase, a technical dialogue will be organized to assess collective progress toward the PA's purpose and long-term goals, focused around three themes: mitigation, adaptation and means of implementation and support. Other crosscutting themes such as response measures and loss and damage may be taken into account through the three thematic areas..

3. ***Consideration of outputs*** *(2023)*

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[2] https://unfccc.int/sites/default/files/resource/ETFReferenceManual.pdf

[3] World Resource Institute, Navigating the Paris Rulebook https://www.wri.org/paris-rulebook/global-stocktake

This phase will take place at the COP in the year of the stocktake itself (i.e., 2023 and every five years thereafter). During this phase, the findings of the technical assessment will be discussed and presented at high-level events. This phase will summarize key political messages, good practices, and identify opportunities for enhancing action and support, as well as challenges.

With regard to space agencies, and the role of CEOS, the substantive elements of the GST of particular interest are hence:

- Mitigation, i.e. reporting, measurement and tracking the progressive decrease in national GHG emissions
- Adaptation to ongoing climate change and its consequences and impacts
- Finance of mechanisms to support the PA
- (Equity among Parties for implementation), this last being implicit in the process

Of these four topics, mitigation of emissions has received the most attention and has been the most actively examined by the scientific and modeling community to date. CEOS has already been very active in response to the specific need to support improved reconciliation of national emissions inventories with satellite observations of GHG concentrations.

Adaptation is nominally set on a par with mitigation in the PA, but adaptation procedures and methods are less proscriptive (see " Pocket Guide to Adaptation Under the UNFCCC "document [4]). However, much relevant work has already been undertaken in CEOS through, for example, the WG Disasters. Adaption is of great importance to many Parties, notably those in developing countries most affected by climate change. There is a very strong potential role for CEOS agencies to help in this aspect and in the related aspects of “Loss and damage”, both as CEOS agencies and in conjunction with ongoing work of CEOS Associates, notably WMO and GEO.

A watching brief on finance and equity should be maintained by CEOS to inform future potential action, including technology transfer and capacity building, and some comments relevant to these aspects are included below.

Mitigation

GHG Emissions

When popular media address climate change it is often the issue of greenhouse gas emissions, their reduction and the industrial, financial and societal consequences that feature largely in their reports. GHG reduction and its monitoring and management has also been the focus of much scientific work in modelling and in measurement of the key parameters of emissions reduction, not least already within CEOS. Progressive emissions reduction is at the heart of the PA and the GST mechanisms.

[4] https://ecbi.org/sites/default/files/PGAdaptation.pdf

CEOS has, through the AC-VC White Paper[5] and through the implementation roadmap[6] of the WG Climate GHG Task Team, already undertaken significant efforts to understand how best to respond to this aspect of the GST. CEOS Agencies have also contributed to initiatives in many countries, notably the USA, Japan, China and Europe, to develop GHG Monitoring and Verification Systems (MVSs) for reconciliation of "top-down" satellite measurements of GHG concentrations and integrated "bottom-up" national inventories of emissions from fossil fuels and land use change. Regional systems are also being considered, for example through the RECCAP[7] project. The MVS also must take into account the contributions of biogenic emissions and emissions resulting from naturally occurring, accidental events, for example wildfires. These systems must also address potential carbon-climate feedbacks, e.g. increased drought and temperature extremes that may require alteration of mitigation pathways. The inversion of satellite observations to deduce emissions is a very complex problem involving multiple processes with high temporal and spatial frequencies.

The satellite constellation necessary for the remote GHG observations is comprehensively described in the AC-VC White Paper and the requirements for these observations are carefully discussed. In order to be able to complete a full MVS, many other elements need to be in place, including fossil fuel emissions (FFE) inventories, estimates of emissions arising from land use and land use change, comprehensive models of natural GHG emissions and removals by land and ocean sinks, transport models and inversion and assimilation procedures. While the Paris Agreement deals only with anthropogenic emissions, the satellite signal is clearly confounded also by natural GHG emissions and removals which may be much larger in magnitude, and which must be included in the overall modeling and inversion process. Several systems are currently being developed, including the EU Copernicus MVS in Europe, the Carbon Monitoring System of NASA in the US and similar integrated systems in Japan and China. Other species and parameters such as CO, NO_2 can be valuable tracers of GHG emissions as co-emitted species and satellite observations of some of these can be invaluable, for example the NO_2 observations of TROPOMI[8] and GEMS/TEMPO. These should also form part of the catalogue of requirements for satellite observations.

Such a system approach has been taken up with the above-mentioned White Paper and implementation roadmap targeting for:

- linking the atmospheric GHG measurement and modeling communities and stakeholders in the national inventory and policy communities through UNFCCC/SBSTA, to refine requirements;
- exploiting the capabilities of the CEOS member agencies, CGMS and WMO Integrated Greenhouse Gas Information System (IG^{3}IS) to integrate surface and airborne measurements of CO_2 and CH_4 flux product in time

[5] https://ceos.org/document_management/Virtual_Constellations/ACC/Documents/CEOS_AC-VC_GHG_White_Paper_Publication_Draft2_20181111.pdf

[6] https://ceos.org/document_management/Meetings/Plenary/34/Documents/CEOS_CGMS_GHG_Constellation_Roadmap_%20V2.4bis.pdf

[7] https://www.globalcarbonproject.org/Reccap/index.htm

[8] www.tropomi.eu

to support inventory builders in their development of GHG emission inventories for the 2013 Global Stocktake, and

- using the lessons learned from this prototype product to facilitate the implementation of a complete, operational, space-based constellation architecture with the capabilities needed to quantify atmospheric CO_2 and CH_4 concentrations that can serve as a complementary system for estimating NDCs in time to support future Global Stocktakes.

We need to ensure that we have the full catalogue of related observations necessary also to generate accurate priors for biogenic emissions and hence derive anthropogenic emissions from the inversion of integrated atmospheric concentrations. It is these terrestrial (and ocean) observations that are addressed in the first two recommendations. These should augment and be included in the catalogue of requirements for satellite observations tabulated in the Annex C to the GHG TT Roadmap.

Space-based atmospheric GHG measurements and atmospheric inverse models can yield integrated estimates of net emissions and uptake on spatial scales spanning large urban areas to global scales. However, these estimates are not source specific. Their results could be made more policy relevant if they could be attributed to fossil fuel combustion, land use change, other human activities or natural processes which cycle carbon into and out of the atmosphere and which need to be taken into account. Natural processes are modeled by Terrestrial Biosphere Models (TBMs), Dynamic Global Vegetation Models (DGVMs) and Global Ocean Biogeochemical Models (GOBMs).

These models are used to generate prior estimates for the natural emissions in MVS inversions based, on a rich suite of parameters. In some cases the model inputs are are relatively simple, for example the VPRM[9] model requires only two satellite based indices (EVI and LSWI) derived from MODIS data, coupled with meteorological data. Other are more complex and seek to describe the behaviour of the terrestrial ecosystems in more detail, driven by parameters such as NPP, LAI, biomass, land cover, temperature and others, provided globally by satellites. Relevant DGVMs are summarized in the TRENDY inter-comparison protocol[10] which covers some 17 different DGVMs and is used in the Global Carbon Project[11] for its gold-standard annual estimates of global emissions.

Oceans also form an important part of the global carbon cycle and there are equivalents of the DGVMs in the ocean, the GOBMs referred to above. Again, many such models exist (some nine are quoted in GCP 2020). These are driven by a combination of *in situ* surface and buoy observations and satellite data of the ocean surface. These need to be included in any comprehensive study of global carbon. Many relevant actions are currently being prepared through the

[9] Mahadevan, P., Wofsy, S. C., Matross, D. M., Xiao, X., Dunn, A. L., Lin, J. C., Gerbig, C., Munger, J. W., Chow, V. Y., and Gottlieb, E. W. (2008), A satellite-based biosphere parameterization for net ecosystem CO2 exchange: Vegetation Photosynthesis and Respiration Model (VPRM), Global Biogeochem. Cycles, 22, GB2005, doi:10.1029/2006GB002735.

[10] http://dgvm.ceh.ac.uk/files/Trendy_protocol%20_Nov2011_0.pdf

[11] https://www.globalcarbonproject.org/

UN Decade of Ocean Science for Sustainable Development[12] and these could form valuable inputs to the CEOS analysis.

It is therefore important that when considering support to carbon MVS systems a full account is taken by CEOS of all the data requirements coming from the different MVS and the many models that characterize biogenic emissions and removals used as priors in them. Such an analysis should be undertaken in conjunction with the relevant modeling community to ensure that all necessary observations are captured by the GHG Roadmap. GCOS too is now looking to define better not only state variables but also requirements for flux observations relevant for understanding the carbon, energy and water cycles. These are likely to feature in the next version of the GCOS Implementation Plan due in 2022, and GCOS would therefore be a valuable partner in this discussion. Much has already been done in this area by the current WGClimate GHG Task Team, and it is to be hoped that such an exercise will comprise mainly the collection and incorporation of requirements already established through model implementations in the community to augment those already captured in the GHG TT Roadmap. It would however be of great value to CEOS to have a comprehensive, documented and consistent set of data requirements for supporting MVS model inversions. This is analogous to the use of ECVs to focus the coherent response of CEOS to the needs of the more general climate modeling community.

We should also note that the establishment of a reliable and robust MVS for GHG emissions, allowing a full inversion of emissions, would also be of great value in improving the understanding of the contributions of major biogenic sources and sinks for the improvement of integrated Earth system models.

Information from a fully implemented MVS would clearly be invaluable in the GST in comparing collective consistency and progress between the sum of emissions reported through national BTRs and the global level and distribution of emissions derived from the MVS. It may, if shown to be sufficiently accurate and reliable, also be useful in aiding some countries in the improvement of their *national* inventories and reporting through their BTRs. This would be an important direct aid to Parties in implementing their own assessments of progress.

The AC-VC White Paper and the WGClimate GHG TT Roadmap have made important progress on the refinement of user requirements and definition of data products needed for inversion of atmospheric observations to emissions. A full analysis led by the GHG TT but involving participation of a wider community is proposed to ensure a comprehensive catalogue of atmospheric, land and ocean data products is achieved. Some progress in this was made by the GEO Carbon project which may help. Inputs from the RECCAP and CHE/CoCO2 projects would also be valuable.

[12] https://www.oceandecade.org/

Before formulating the core recommendations, the approach of the GHG implementation roadmap shall be recalled:

- Refinement of User Requirements including those from UNFCCC, GCOS and the IPCC TFI and support to the UNFCCC Secretariat and the Parties in the Synthesis and Assessment process of the Global Stocktake;
- Delivery of pilot dataset to uptake the EO datasets in providing support to inventory builders in their development of the GHG inventories for the 2023 Global Stocktake; and
- Delivery of an Initial operational system to integrate observations from the evolving ground-based, airborne and space-based atmospheric GHG observing networks into MVS.

Recommendation 1: WGClimate GHG Task Team should consult with the relevant elements of CEOS, including Associates such as ISC, WCRP and GCOS, together with modelers, to check the GHG Implementation roadmap on completeness concerning requirements for terrestrial observation (SIF; NPP, land cover, biomass, etc.) for supporting mitigation actions through the development of MVS. The actions in Annex C of the roadmap shall be complemented as needed.

Recommendation 2: The need for parallel inputs to ocean models deemed necessary for the support of MVS and for a wider validation of carbon flux estimates globally should be considered and appropriately combined into the actions in Annex C of the GHG roadmap. This should also be led by the WGClimate GHG TT in cooperation with Ocean VCs and modeling groups, together with GCOS, GOOS, WCRP and individual agencies.

Recommendation 3: The results of the actions from the above recommendations should inform (a) the report of CEOS to UNFCCC/RSO discussion on observation to support the implementation of the Paris Agreement and should pro-actively flow into (b) the consultancy process of the UNFCCC / Ad hoc group for the Synthesis Report on Observations for the GST. CEOS should also report on this at the Earth Information Day at COP26. CEOS and its Agencies should argue to be a primary source of consistent global land and ocean surface data (land cover type, biomass, phenology…) in the discussion with UNFCCC/RSO, in addition to providing the integrated measurements of GHG and co-emitted species in the atmosphere.

There are focal areas on the globe where there is greater modeling uncertainty about current and projected emissions of GHG. A large-scale field experiment similar to the IMBIE project for ice sheets has the potential to bring together a complete suite of observations and models in specific critical zones currently regarded as tipping points of terrestrial emissions in the near future. Examples are the Amazon Basin and the Siberian tundra.

Recommendation 4: CEOS should consider, in conjunction with modelers, setting up one or more focused observational campaigns in the areas suggested above, or others, as a major contribution to the understanding of the trends of GHG emissions from natural sources in key areas.

CEOS should also consider how best to relate the work of the WGClimate GHG Task Team with the AFOLU Roadmap Team to ensure a coherent accounting for GHG emissions and inventories across mixed spatial and temporal scales: this is considered further below.

AFOLU

Aside from fossil fuel emissions (FFEs) the only element of reporting of national emission reduction goals in the NDCs is that arising from changes in land use associated with agriculture, forestry and other land uses – AFOLU. The mechanisms for implementing AFOLU are well established and are set out in the 2006 IPCC Guidelines as modified by the 2019 Refinement for National GHG Inventories[13]. At the lowest (Tier 1) level, emissions from land use change are characterized by a convolution of *activity data* – a transition matrix of observed changes in land use – with *emissions factors*, the emissions of GHG released per unit area of each category of land conversion in the transition matrix.

Tiers 2 and 3 reporting go to further levels of detail, for example where more accurate locally specific emissions factors may be applied, and require yet further types of information. There is considerable scope for an increase in the use of satellite data in providing spatially disaggregated information, rather than the overall area changes required by Tier 1 reporting. By improving their AFOLU reporting to meet higher Tier level requirements countries stand to benefit from international finance arrangements associated with nature-based solutions.

Satellite data provide the fundamental information on land use change, and may in due course be able to assist in the improvement of emissions factors through data products such as LUC, fire incidence, fire radiative power and biomass particularly in the context of an operational MVS. Satellite data may also be of assistance in resolving the relationships of different definitions of land cover that arise from different perfectly legitimate keys, and for reconciling different approaches taken by different national implementations. This is especially important when such differences of definition lead to inconsistent final emission reporting. As more countries move towards spatially explicit reporting under AFOLU, satellite data become of increasing importance. Awareness of new methods and parameters that are relevant, for example forest biomass, may be limited and should be fostered.

The nominal cycle for AFOLU reporting is five-yearly, but it is likely that more complex and frequent reporting of relevant data will be required and achievable. In the EDGAR database, all AFOLU emissions are already spatially disaggregated by objective, repeatable and reported methods.

A full analysis of the requirements and capacities of CEOS agencies to assist UNFCCC in the AFOLU process is being undertaken by the CEOS AFOLU Roadmap Team, analogous to the WGClimate GHG Task Team already mentioned in regard

[13] https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

to MVS. This work should also continue with the full involvement of non-space actors as envisaged. It is very important that the two groups (GHG/AFOLU) cooperate so as to ensure that there is no confusion between reported land use changes accommodated in the AFOLU process and emissions from land use change or disturbance included in the prior emissions for MVS. AFOLU can also provide useful boundary conditions for the integration of emissions through MVS but the timescales are quite different and this difference needs to be respected. Integrated fluxes derived from the GHG effort could be made more valuable in the GST inventory development process if the observed AFOLU and FFE components could be clearly separated on national scales.

Developing countries are likely to benefit more from the provision through CEOS of fundamental data for AFOLU as there is likely to be less complete local sources of data. In addition, a much greater proportion of their emissions arise in land use change, notably deforestation, than in FFEs by comparison with industrialised countries.

Recommendation 5: The AFOLU Roadmap Team should continue the work it has started for CEOS, reflecting the decisions taken at CEOS Plenary 2020. The AFOLU Roadmap Team and WGClimate GHG Task Team should work together to ensure consistency between data for emissions reported via AFOLU and for prior biogenic terrestrial emissions, and those due to changing land use, in implementing monitoring and verification systems. These need to be consistent on both temporal and spatial scales. The WGClimate GHG Task Team should ensure that their Roadmap is consistent with the outcomes of this discussion.

Recommendation 6: It is recommended that to help in ensuring the take-up of satellite-based methods for AFOLU (and indeed in the context of MVS) CEOS should work with a few selected demonstrator countries to assist them in their national reporting under AFOLU (the model of GFOI can be compared). USGS through its SilvaCarbon programme has volunteered to lead this work, together with relevant CEOS bodies (LSI-VC, AFOLU Roadmap Team, CEOS member contributions).

Adaptation

The second very important area of the GST for space agencies concerns support to Adaptation. Although much of the political discussion focuses mechanisms to reduce the impact of humanity on climate change though reduction of GHG emissions, an equally important aspect is the ability of society to deal with the future evolution of climate due to past GHG emissions which have yet fully to manifest themselves as a forcing function. This is sometimes neatly expressed as managing the unavoidable, as opposed to avoiding the unmanageable.

Article 7.1 of the PA establishes a global goal on adaptation:

- *"to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change, with a view to contribute to sustainable development and ensure an adequate adaptation response in the context of the 2°C temperature goal".*

Unlike mitigation, the global goal on adaptation set by the PA is aspirational in nature, without concrete targets or metrics. Ultimately Parties communicate their adaptation priorities, implementation, and support needs, but they are free to submit information they consider most adequate. This aspect represents an opportunity for the systematic observation community to provide appropriate observations in support of the adaptation process, and is particularly important for some less developed countries which we know may well be most immediately and significantly affected by climate change, while themselves being responsible for only a tiny fraction of overall GHG emissions.

Parties are invited to submit their intentions on adaptation in their NDCs. This is not compulsory, but in the first round of Intended NDCs some 137 countries included an adaptation component. Information on adaptation may be in the form of National Adaptation Plans (NAPs), National Communications or an NDC Adaptation Statement, but more recent submissions of enhanced NDCs show a trend to add strong links to their NAPs. In the case of least developed and developing countries that seek funding for support for either developments of NAPs (via the Green Climate Fund) or their implementation through projects supported by various financial means, a full NAP must be submitted. Some twenty-one NAPs from developing countries are today registered with the UNFCCC Secretariat[14]. These various communications provide a valuable source of requirements for adaptation data.

Furthermore, the PA includes provisions on the issue of "Loss and damage" associated with unavoidable impacts of climate change, which for the first time is addressed separately from adaptation. Parties will include information on loss and damage in reporting under the transparency framework and the GST. UNFCCC has asked relevant providers to share information on what the wider Earth observation community is already supporting through technical assistance in specific developing countries along identified support areas, in some of which CEOS agencies are already active (e.g. use of space-based EO for early warning systems, nature-based solutions and disaster risk reduction, disaster management). GEO is working with UNFCCC to coordinate inputs to this.

The aspects of promoting national adaptation and finding ways to address losses and damages are particularly important for least developed countries which we know may well be most immediately and significantly affected by climate change, while themselves being responsible for only a tiny fraction of overall GHG emissions.

[14]NAPCentral:https://www4.unfccc.int/sites/NAPC/News/Pages/national_adaptation_plans.aspx

The requirements on satellite data for adaptation are likely to be quite different from those needed either for modelling or mitigation. They will often be local in nature, with problems addressed at high spatial resolution. More than in any other area other forms of non-physical data - socio-economic, demographic – will be critical and satellite data can only ever be a component of any solution. However there are still aspects that can be considered by CEOS.

Some common data will be invariably useful – medium-to-high resolution (100m - sub10m) land cover data are likely to be valuable at all scales from the local to the global, as are other data such as air quality, LST and so on. Ensuring access to reliable and repeatable land cover data might be a priority for CEOS. Satellite data are likely to be particularly valuable in less developed countries where local environmental data may be more scarce. Partnership with Development Agencies such as the World Bank, Asian Development Bank or national Aid programmes will help and it will be critical to ensure a full partnership with local technical bodies (e.g. Agrhymet and CERMES in Nigeria) if CEOS agencies themselves wish to be fully involved in the end-to-end delivery of adaptation services.

The NAPs submitted to UNFCCC are a very valuable and definitive source of requirements for spatially explicit information, some of which can be derived from satellite data. A selection of these should be studied to gauge their overall relevance and usefulness as source documents for CEOS. In some less developed countries it is likely that satellite data, notably land cover, may be able to provide a proxy for otherwise unavailable information on more subtle aspects of national life or infrastructure. They can also be invaluable in providing a baseline against which future progress can be measured. Chile has also pressed for countries to incorporate the impacts of climate change on the ocean in their NDCs, through the 'Because the Ocean' Declaration launched under its Presidency of CoP25[15].

A need for sharing of best practice and use cases on adaptation an addressing loss and damage is implicit in the aspiration of equity among countries in the PA and welcomed by the UNFCCC Secretariat. Supporting free and open access to satellite data for purposes of adaptation is an important area for CEOS to address in this context.

GCOS has also begun to address the issue of observations for adaptation, beginning with a joint workshop with IPCC and UNFCCC in 2015[16], and more recently has established a Task Force on Adaptation to consider this in the context of the next Implementation Plan. Satellite data will only ever be one element of the data needs, as already mentioned, and CEOS should work with other data providers to understand the overall needs.

[15] https://sdg.iisd.org/news/chile-launches-platform-for-science-based-ocean-solutions-at-cop-25/

[16] https://unfccc.int/files/documentation/submissions_from_non-party_stakeholders/application/pdf/543.pdf

The Group on Earth Observations (GEO) has also recently established a Climate Change Working Group with four sub-groups, one of which focuses on enhancing the use of Earth observation for adaptation and loss and damage and some CEOS agencies will already have been involved in that discussion. One priority deliverable for GEO in 2021, in collaboration with the UNFCCC Secretariat, includes developing supplementary technical guidance on integrating EO into NAP processes. While this is clearly focused on adaptation, the information produced is also essential to NDCs/BTRs and ultimately GST activities. GEO should also be well placed to tap into non-space and non-physical sources of data needed for adaptation and addressing loss and damage, and this initiative presents an important possible opportunity for CEOS.

Adaptation also brings in the concept of climate services, although this is a term that means many things to different people. Notwithstanding this, CEOS should work with the providers of climate services both internally in CEOS among agencies (WG Disasters, Copernicus Climate Change Service, NSIDC for example); with the World Meteorological Organisation (WMO), a CEOS Associate, and its Global Framework for Climate Services; with GCOS, who are also addressing these issues; with National Meteorological and Hydrological Services (NMHS), who have important statutory responsibilities in this area; with the GEO Climate Change Working Group and the broader GEO constituency; and with other bodies who will also contribute to the provision of such services, including those in the financial and development finance sector. It would also be of great value to be able to include representatives of the insurance and re-insurance industry in such discussions. CEOS should work in partnership with these bodies to assess needs and to derive requirements for data products relevant to adaptation.

Recommendation 7: CEOS should work with the various partners set out above to identify data requirements and actions for CEOS in relation to adaptation, including participation of relevant CEOS groups such as WG Climate and WG Disasters. Case studies might be of value to demonstrate competence and relevance. Partnership with specific countries in implementing their NAPs could be of value, as in the case of AFOLU above, both to demonstrate worked examples and to strengthen support for this approach at UNFCCC, including at CoPs.

Finance flows and means of implementation and support, and Equity

For implementing the PA there are several mechanisms foreseen for support of developing (Non-Annex I) countries. These include the Green Climate Fund[17], funding through the UNFCCC Financial Mechanism managed by the Global Environment Facility[18] and others. There is of course no question that CEOS agencies would contribute financially to any of these fund mechanisms, but the implementation of projects under them are often related to adaptation and will require support from satellite data sets. These are discussed above. There is also a critical need to ensure oversight and accountability of projects implemented

[17] https://www.greenclimate.fund

[18] http://www.thegef.org/

through climate funding mechanisms for both mitigation and adaptation actions. Satellite data can provide a valuable objective assessment of progress against targets set for successful implementation of such projects.

We should recognise also that developing country Parties would not trust or accept reports without co-design and co-production. Therefore, any effort that aims to encourage developing countries to improve their use of satellite data has to follow strict ethical guidelines and has to promote "data democracy". CEOS will need to follow the development of climate funding mechanisms to be able to propose technical approaches that meet the needs and constraints of developing countries. This approach is recognised in the PA, where there is also specific reference to the need for technology and capacity building to be made available to these countries in their climate actions. Developed countries are required to submit information on finance, capacity building and technology transfer as part of the Enhanced Transparency Framework (Article 13).

Sharing of technology reflects the principles of equity to be established among Parties in the implementation of the Agreement. Ensuring free and fair access to data is a key element of this equity, and CEOS should continue to undertake to supply data in accord with these principles to the fullest extent possible. Access to appropriate software and other data processing tools should also be granted as widely as possible for such purposes, including an emphasis on open source software and cloud processing. Capacity building will also be critical. A particularly virtuous approach occurs when an institution provides open source software and is able to build a community of users that help each other. A good example is ESA's STEP Forum, where users of ESA's SNAP and other toolboxes can find help in solving their doubts and problems

Note that, more generally, there is strong evidence[19],[20] that financial constraints introduced either by governmental regulatory mechanisms or by commercial interests of individual investment funds or companies themselves will likely provide very strong drivers for increased sustainability of businesses and reducing their emissions. This is likely to be a major driver for future climate actions and in due course will evolve requirements for CEOS, but it is outside the immediate scope of the Paris Agreement and not further considered here. We should however note that CEOS Associates, notably WMO, have for some time been involved with strengthening the “climate rationale” of proposals submitted to the Green Climate Fund. GEO is also looking to establish a similar relationship with the GCF.

Recommendation 8: CEOS should maintain a watch over the implementation of projects funded through climate fund mechanisms to ensure that all appropriate assistance is given by agencies in their implementation and governance.

[19]https://www.fsb-tcfd.org/

[20] https://www.ft.com/content/a71feaac-d3f4-4e76-a60c-c68924b06dfd

Supporting the IPCC

The ultimate objective of the Paris Agreement is couched in terms of limiting future temperature rise, but this can only be related to GHG emissions and their reduction by climate projections based on increasingly complex models. These models are dependent on a wide variety of *in situ* and remote observations, most of them described as Essential Climate Variables (ECVs) in the GCOS Implementation Plan[21]. The requirements for ECVs that support modelling are well established, although continually evolving, and are not addressed in this paper that considers specifically how agencies can support the GST mechanism.

This paper focuses on the needs for the GST that are more specifically related to the undertakings of IPCC Working Groups WGII (Adaptation) and WGIII (Mitigation) but we must continue to support the work enhancing scientific knowledge on the physical aspects of the Earth System with observations and model results through IPCC WG I (Science).

To assess the actual status and predict the future of climate change, the systematic monitoring of the physical Earth System needs to be continued in a sustained fashion. This requires the continued provision of satellite data to provide the Essential Climate Variables. Although not explicitly stated, this is implicit in the requirements for the GST.

By the actions suggested in this paper CEOS will in future increase its support across all aspects of the work of the IPCC, and hence provide increased support to Parties.

Recommendation 9: CEOS must continue all efforts to provide the necessary climate data records which support the assessment of the actual status of the climate and the prediction and projection of future climate change, its response to changing GHG emissions and other drivers, and impacts of climate change.

[21] https://gcos.wmo.int/en/gcos-implementation-plan