



Systematic observations for assessing, mitigating and adapting to climate change

by Reuben Sessa, Programme Officer, Global Terrestrial Observing System (GTOS), and John Latham, Programme Director, GTOS

The 2007 Intergovernmental Panel on Climate Change (IPCC) assessment unequivocally states that humans have significantly changed the composition of the atmosphere, and that as a result, our climate is changing.

Climate change and climate variability in local, regional and global systems are a cause for concern, and have generated considerable political attention and stakeholder engagement. Clearly, climate change is a real threat to development and puts additional pressure on already limited resources. What is most concerning is that these phenomena are

most likely to affect developing countries, which have the least capacity to adapt and meet new challenges.

In order to attribute the causes of climate change, analyse its potential impacts, evaluate options for adaptation and enable the characterization of extreme events such as floods, droughts and heat waves, global, high-quality and comprehensive observations are required. Without such baseline data, it will not be possible to develop the products needed by policy makers and other stakeholders for this purpose.

These observations are not only essential to meet the challenges of climate

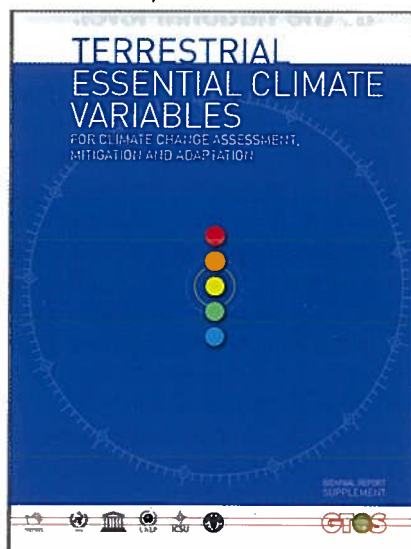
change; they are required for sustainable development and to meet the objectives of the Millennium Development Goals (MDGs). Such undertakings can only be achieved through an international coordinating mechanism and the use of common methodologies and standards.

A deeper understanding of global change and its consequences

In response to international calls for a deeper understanding of global change in the earth system, the Global Terrestrial Observing System (GTOS) was established in January 1996 by its five co-sponsoring organizations¹⁾ Through its Secretariat and technical panels, GTOS is playing an important role towards improving the understanding of the terrestrial components of the climate system, the causes of change and its consequences.

GTOS supports the terrestrial data and observational requirements of

Recent GTOS report on the Terrestrial ECVs.



1) The Food and Agriculture Organization (FAO), the International Council for Science (ICSU), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO).



the United Nations Framework Convention on Climate Change (UNFCCC). It assists in the implementation of the 13 terrestrial Essential Climate Variables (ECVs) (see [page 34](#)) together with the oceanic and atmospheric ECVs, which were identified in the implementation plan developed by the Global Climate Observing System (GCOS) as observations that are currently feasible for global implementation and that have a high impact on the requirements of the UNFCCC and other stakeholders.

Gaps and inconsistencies in terrestrial observations

Although an increasing significance is being placed on the terrestrial domain in regards to climate change activities, the land observing system remains the least developed. The creation of an effective and well supported intergovernmental technical framework for terrestrial observations, similar to those that exist for the atmospheric and oceanic domains, would greatly contribute to overcoming the above difficulties.

Such a framework would be vital for generating the tools, methodologies, data, information and support required

by the UNFCCC to meet its long-term objective to stabilize greenhouse gas concentration in the atmosphere. It will also assist countries in meeting their requirements when confronting the effects of climate change.

Realizing this need, the UNFCCC Conference of Parties invited, in its ninth session (Decision 11/CP.9; UNFCCC, 2003) and in consultation with other stakeholders, GTOS and its sponsors “to develop a framework for the preparation

of guidance materials, standards and reporting guidelines for terrestrial observing systems for climate and associated data and products”.

In response to this request, the GTOS Secretariat identified three possible framework options, each with different strengths and weaknesses. If imple-



FAO Headquarters, Rome, Italy. (Photo: G.Bizzari)

About the authors



Reuben Sessa, is Programme Officer of Global Terrestrial Observing System (GTOS), coordinating its climate change activities, including the collaboration

with the United Nations Framework Convention on Climate Change (UNFCCC). His recent activities include the coordination of the analysis of available standards and methodologies for the 13 terrestrial Essential Climate Variables (ECVs) and assisting in developing the different terrestrial framework options. He holds a PhD in genetic engineering and has been working at the Food and Agriculture Organization (FAO) for over seven years.



John Latham is Programme Director of the Global Terrestrial Observing System (GTOS), which is hosted by the Food and Agriculture Organization of the United

Nations (FAO). In addition, he coordinates the Geographic Information Systems (GIS) and poverty mapping activities of FAO, as well as running numerous projects and initiatives such as the FAO/UNEP Global Land Cover Network (GLCN), an initiative supported by the government of Italy.

mented appropriately, any of the options should satisfy the identified requirements. A detailed analysis of the advantages and disadvantages of each option, including costs, mechanisms for endorsement and timelines was provided to the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC for its consideration.

The final form of the selected option will be based on the outcome of further discussions. The aim is that it should be broadly acceptable and adopted by all countries. It should act as a mechanism for arriving at international scientific or technical consensus, in particular, concerning the endorsement of standards and guidelines. The framework should also meet the future needs and requirements of the UNFCCC, as well as other stakeholders such as the Convention on Biological Diversity (CBD) and the Convention to Combat Desertification (CCD).



A station measuring carbon fluxes in the Italian Alps

Harmonizing data

One of the main objectives of the international terrestrial framework is the development of standards and their uptake by national institutions. This is fundamental to ensure data compatibility between different producers. Only harmonized, consistent data sets can provide the multi-user community – which includes the UNFCCC, as well as countries and other organizations dealing with elements of global change – with the high-quality global data required to achieve their purpose.

At the request of SBSTA, the GTOS Secretariat, in collaboration with its partners, has undertaken a review of the available standards, guidelines, measurements and processing protocols already in use by national institutions and international organizations. The review has revealed that few definitive standards exist for the 13 terrestrial ECVs.

However, guides discussing various *in situ* measurement methods and sampling protocols were identified for several of the ECVs. These documents

are potentially good starting points to develop the required standards. For example, the Land Cover Classification System (LCCS) developed by the Food and Agriculture Organization (FAO) and the United Nations Environment Programme (UNEP) is now widely accepted as an international standard for land cover inventory and change. It has been submitted to ISO as a new work item proposal, and is currently under review.

“Climate change is a real threat to development.”

In addition, international space agencies have agreed through the Committee for Earth Observation Satellites (CEOS) to provide multi-decadal climate products covering terrestrial, oceanic and atmospheric domains. GTOS and its science panels are collaborating with the CEOS working group on calibration and validation, to establish protocols and benchmarks to ensure data comparability. GTOS will continue to work on developing standards for terrestrial ECVs for both *in situ* and satellite components.





Collaborating with ISO

GTOS sponsors such as FAO and the World Meteorological Organization (WMO) already have experience in developing international guidelines in areas such as meteorology, climate and land cover. Recently, FAO has been collaborating with ISO technical committee ISO/TC 211, *Geographic information/ Geomatics, to develop the Land Cover Classification System (LCCS) into an ISO standard* (see “Measurements to know and understand our world” on [page 35](#)).

WMO has also been working with ISO to establish a collaborative mechanism to develop standards. The ISO process for the development of standards on terrestrial ECVs is seen as an open, public method, which has a long and tested track record. Established ISO technical committees, such as ISO/TC 211 and ISO/TC 207, *Environmental Management*, already have the mandate to accommodate the terrestrial ECVs. GTOS (with FAO and WMO) has established a dialogue with ISO to develop a common terrestrial framework. This is one of the previously mentioned options submitted to the UNFCCC.

“The ISO process is seen as an open, public method for establishing standards with a long and tested track record.”

Bali outcomes and future steps

At the UNFCCC climate change conference in Bali, in December 2007, SBSTA welcomed the progress that has been made on the assessment of standards. It also appreciated the efforts of the GTOS Secretariat in the development of a framework for the preparation of guidance materials, standards and reporting guidelines for terrestrial observing systems for climate. GTOS is now encouraged to develop a final framework proposal for submission at SBSTA 29 (Poland, December 2009), which meets the following criteria:

- standards should be developed on a scientifically sound basis;
- the framework should involve governments in the development of standards and guidance materials, and in their implementation;
- ease of access to those standards and guidance materials should be ensured;
- the process for developing the standards and guidance materials and the operation of the framework should be cost-effective and sustainable, and take into account existing standards and guidance materials;
- the framework should be flexible in view of future needs and developments in this area.

GTOS and its partners will use the above criteria and develop a final proposal for consideration by UNFCCC. In view of the collaboration and progress that has already been made, it is likely that it will include an ISO component. ■

Web links

Terrestrial ECVs report: www.fao.org/gtos/doc/pub52.pdf

Review of available standards: www.fao.org/gtos/topcECV.html

Framework development: www.fao.org/gtos/topcFRAME.html

UNFCCC: <http://unfccc.int/>

Essential Climate Variables

The Global Terrestrial Observing System (GCOS) identified 47 Essential Climate Variables (ECVs) considered to be technically and economically feasible for systematic observation. While some of the variables consist of global measurements, most represent geographically distributed data. They are divided into three categories: atmospheric, ocean, and terrestrial. Below are the 13 terrestrial ECVs

(for more information see: <http://www.wmo.int/pages/prog/gcos/index.php?name=essentialvariables>).

River discharge



Freshwater discharge from rivers into oceans influences the climate system and can affect oceanic circulation patterns. Monitoring is important to detect changes resulting from climate change.

Lake levels



Information on water volume changes and monitoring is crucial for water resources management and regional and global water-cycle studies. It can provide critical indicators of climate change in the region.

Ground water



Nearly 30% of global freshwater resources are taken from groundwater supplies and in some developing countries this accounts for the greatest part of their supply. As a result of a changing climate and a growing population, these resources are threatened with depletion, salinization and contamination. Despite its importance, ground water is rarely monitored.

Water use



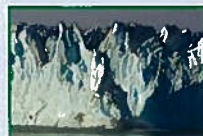
Fresh water is used in agricultural, industrial and household activities, as well as for maintaining ecosystems. In developing countries, irrigation accounts for more than 90% of the water taken. Water is therefore crucial for food production and security, and reliable observations are essential to predict the effects of climate change on food production.

Snow cover



Over 50% of the Earth's land surface can be covered by snow during the winter of the Northern Hemisphere. Snow affects the surface's albedo and energy balance, as well as modifying the overlying atmospheric thickness and surface temperature. Its characteristics will determine the state of permafrost (continuously frozen land), as well as the depth and timing of seasonal freezes and thaws, glaciers, ice sheets and sea ice.

Glaciers and ice caps



Glaciers react strongly to climatic changes and therefore constitute a good source for monitoring changes. Glacier shrinking could affect sea-level rise, fresh water resources and human activities.

Permafrost and seasonably frozen ground

Earth materials that remain frozen for at least two years in a row are referred to as permafrost. As the globe warms, permafrost landscapes begin to thaw and erode. Permafrost temperature provides a useful indicator of terrestrial climate changes.



Albedo and reflectance anisotropy

Land surface albedo is a key parameter that controls the planetary radiative energy budget. Changes in snow cover and flooding patterns for instance are linked to changes in land albedo.



Land cover

Land cover refers to the observed surface of the earth, whether vegetation or human settlements. Observations are important for ensuring a sustainable management of natural resources, understanding and mitigating climate change, addressing food security, and other important issues.



Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)

Referring to the photosynthetically active radiation absorbed by vegetation canopy, FAPAR, provides a reliable variable for monitoring seasonal cycle and variability of vegetation activity related to photosynthesis. This is important for the energy balance of ecosystems and the estimation of the carbon balance.



Leaf Area Index (LAI)

Referring to the amount of leaf material in ecosystems, this variable is important for monitoring the growth and strength of vegetation on the planet.



Biomass

Biomass refers to the mass of all organic matter at a specific moment, and is affected by photosynthesis (produces biomass) and fires (destroys biomass). It acts as a carbon sink during through photosynthesis, and is increasingly used for generating bioenergy. Forests are an important source of biomass, playing a crucial role in reducing carbon dioxide and mitigating the effects of climate change. Deforestation on the other hand, is the largest source of greenhouse gas emissions in developing countries.



Fire disturbance

Fire can transform land cover as well as produce atmospheric emissions. It's also an important land management practice. This information is used for estimating atmospheric emission, developing assessments and for planning and operation of fire management and preparedness.

