Terrestrial Domain Actions

Action T1	Improve coordination of terrestrial observations
Action	Establish mechanism to coordinate terrestrial observations: this will be particularly important for climate change impacts and adaptation where local information will be critical and will not be provided through GCOS directly. It includes biodiversity and natural resources information and could also incorporate socio-economic components (e.g. health) so as to become fine-tuned with post-2015 frameworks. This would be based on discussions with stakeholders and could include a formal framework or regular meetings to exchange ideas and coordinate observational requirements.
Benefit	Efficient observing systems with minimal duplication, delivering consistent and comparable data to a range of different users
Time frame	2017: Hold workshops to discuss way forward 2019: Mechanism in place.
Who	All involved in terrestrial observations. Initially TOPC, GEO, ICSU, GOFC-GOLD, FluxNet, NEON
Performance indicator	Presence of active mechanism
Annual cost	US$ 100 000–1 million

Action T2:	Develop joint plans for coastal zones
Action	Jointly consider observations of coastal zones (including sea ice, mangroves and sea grass, river and groundwater flows, nutrients, etc.) to ensure the seamless coverage of ECVs and the global cycles in these areas
Benefit	Consistent, accurate and complete monitoring of coastal zones
Time frame	2017: joint meetings 2019: agreed plans
Who	All involved in coastal observations. Initially TOPC, OOPC
Performance indicator	Plan completed
Annual cost	US$ 1 000–10 000k

pmathieu :

the coastal zone is critical , a lot of people live there and care about it, so having a section dealing with the exchanges and fluxes would point that restring the importance of land and ocean as providing ecosystem services,

Action T3:	Terrestrial monitoring sites
Action	Review the need for establishing a public database of sites that aim to record climate-relevant data and their data. Consider the usefulness of establishing a set of GCOS terrestrial monitoring sites that aim to monitor at least one ECV according to the GCMP.
Benefit	Improved access to monitoring and increased use of the data
Time frame	One year for review
Who	GCOS
Performance indicator	Report on GCOS terrestrial monitoring sites
Annual cost	US$10 000–100 000

Ntapper:

There is a clear link here to the proposal from AOPC (with support from TOPC) to establish a GCOS Surface Reference Network (GSRN) that comprises (initially a limited number of) sites around the world measuring a range of atmospheric and terrestrial ECVs.

c5hemac5hema :
By nature the set of terrestrial sites useful for a specific ECV monitoring will vary.

For land cover for examples, a reference data portal containing many published data have been assessed and made available (http://www.gofcgold.wur.nl/sites/gofcgold_refdataportal.php). More consistent reference data is collected by the EC Copernicus global land monitoring service and will be made available in the future (https://land.copernicus.eu/global/products/lc).

For biomass, several plot network data are being combined but most of them are not openly available. There is an joint effort by the in-situ community and the space agencies to develop a cal/val database for future biomass missions from space expected in the next 5 years.

Action T4:	Review of monitoring guidance
Action	Review existing monitoring standards/guidance/best practice for each ECV and maintain database of this guidance for terrestrial ECVs
Benefit	Improved consistency and accuracy of results to meet user needs
Time frame	Review: 2017–2018, maintain database as of 2019
Who	TOPC
Performance indicator	Presence of maintained database
Annual cost	US$ 1 000 –10 000

Mzemp:
Progress:

GTN-G provides a collection of guidelines and best practices for glacier monitoring: http://www.gtn-g.ch/guidelines/
the WGMS proivdes guidelines and best practices for monitoring glacier changes: http://wgms.ch/data_guidelines/

Action T5:	Develop metadata
Action	Provide guidance on metadata for terrestrial ECVs and encourage its use by data producers and data holdings
Benefit	Provide users with a clear understanding of each dataset and the differences and applicability of different products for each ECV
Time frame	2018
Who	TOPC in association with appropriate data producers
Performance indicator	Availability of metadata guidance
Annual cost	US$ 1 000 –10 000

Nadinegob:
See

http://cfconventions.org/Data/cf-conventions/cf-conventions-1.6/build/cf-conventions.html
https://www.unidata.ucar.edu/software/thredds/current/netcdf-java/metadata/DataDiscoveryAttConvention.html

and

http://vocab-test.ceda.ac.uk/collection/cci/cci-content/ (platforms, sensors...)

pmathieupmathieu :
would be great to use the concept of linked data using RDF for traceability

sdietrichsdietrich :
see

full list of OGC standards including metadata: http://www.opengeospatial.org/docs/is
INSPIRE (EU): http://inspire-geoportal.ec.europa.eu/editor/
full list of standards (including metadata) accessable by GEO Discovery and Access Broker: http://www.geodab.net/
WIGOS Metadata Standard (WMDS): https://library.wmo.int/opac/doc_num.php?explnum_id=3653

Action T6:	Identify capacity development needs
Action	Identify capacity-development needs to inform GCM and other capacity-building initiatives; identify specific improvements that could be supported by GCM
Benefit	Improved monitoring in recipient countries
Time frame	Ongoing
Who	TOPC and GCM
Performance indicator	Project proposals and Implemented projects
Annual cost	US$ 10 000–100 000

Pmathieu:
need to link with multilateral development bank as they are the main enabler of large-scale capacity building activity. e.g. pilot programme on climate resilience

Action T7:	Exchange of hydrological data
Action	In line with WMO Resolutions 25 (Cg-XIII) and 40 (Cg-XII), improve the exchange hydrological data and delivery to data centres of all networks encompassed by GTN-H, in particular the GCOS baseline networks, and facilitate the development of integrated hydrological products to demonstrate the value of these coordinated and sustained global hydrological networks.
Benefit	Improved reporting filling large geographic gaps in datasets
Time frame	Continuing; 2018 (demonstration products)
Who	GTN-H partners in cooperation with WMO and GCOS
Performance indicator	Number of datasets available in international data centres; number of available demonstration products
Annual cost	US$ 100 000–1 milion

Action T8:	Lakes and reservoirs: compare satellite and in situ observations
Action	Assess accuracy of satellite water-level measurements by a comparative analysis of in situ and satellite observations for selected lakes and reservoirs
Benefit	Improved accuracy
Time frame	2017–2020
Who	Legos/CNES, HYDROLARE
Performance indicator	Improving accuracy of satellite water-level measurements
Annual cost	US$ 10 000–100 000

Sdietrich:

I will contact the responsible contact within GTN-H for leading the rapport

Action T9:	Submit historical and current monthly lake-level data
Action	Continue submitting to HYDROLARE historical and current monthly lake-level data for GTN-L lakes and other lakes weekly/monthly water-temperature and ice-thickness data for GTN-L
Benefit	Maintain data record
Time frame	Continuous
Who	National Hydrological Services through WMO CHy and other institutions and agencies providing and holding data
Performance indicator	Completeness of database
Annual cost	US$ 100 000–1 million (40% in non-Annex-1 Parties)

sdietrich :

I will ask the responsible colleagues from GTN-H whether there is interest to contribute to TOPC as the responsible rapporteur.

Action T10:	Establish sustained production and improvement for the Lake ECV products
Action	Establish satellite-based ECV data records for Lake-surface water temperature, Lake ice coverage and Lake water-leaving reflectance (Lake colour);Implement and sustain routine production of these new satellite based products; Sustain sustain efforts on improving algorithms, processing chains and uncertainty assessments for these new ECV products, including systematic in situ data sharing and collection in support of ECV validation; Develop additional products derived from Lake water-leaving reflectance for turbidity, chlorophyll and coloured dissolved organic matter
Benefit	Add additional Lake ECV products for extended data records; provide a more comprehensive assessment of climate variability and change in lake systems
Time frame	Continuous.
Who	Space agencies and CEOS, Copernicus Global Land Service, GloboLakes and ESA CCI
Performance indicator	Completeness of database
Annual Cost	1–10M US$ (40% in non-Annex-1 Parties)

Nadinegob:

Copernicus Global Land Service had included in-land water products:

see https://land.copernicus.eu/global/products/wb

Check if it fits this action ...

Sdietrich:
I will contact the responsible contact within GTN-H for leading the rapport.

Action T11:	Confirm Global Terrestrial Network for River Discharge sites
Action	Confirm locations of GTN-R sites; determine operational status of gauges at all GTN-R sites; ensure that GRDC receives daily river discharge data from all priority reference sites within one year of observation (including measurement and data transmission technology used)
Benefit	Up-to-date data for all areas
Time frame	2019
Who	National Hydrological Services, through WMO CHy in cooperation with TOPC, GCOS and GRDC
Performance indicator	Reports (made In cooperation with GTN-H partners) to TOPC, GCOS and WMO CHy on the completeness of the GTN-R record held in GRDC, including the number of stations and nations submitting data to GRDC, National Communication to UNFCCC
Annual cost	US$ 1–10 million (60% in non-Annex I Parties)

Action T12:	National needs for river gauges
Action	Assess national needs for river gauges in support of impact assessments and adaptation and consider the adequacy of those networks
Benefit	Prepare for improvement proposals
Time frame	2019
Who	National Hydrological Services, in collaboration with WMO CHy and TOPC
Performance indicator	National needs identified; options for implementation explored
Annual cost	US$ 10–30 million (80% in non-Annex I Parties)

Action T13:	Establish a full-scale Global Groundwater Monitoring Information System (GGMS)
Action	Complete the establishment of a full-scale GGMS as a web portal for all GTN-GW datasets; continue existing observations and deliver readily available data and products to the information system
Benefit	Global, consistent and verified datasets available to users
Time frame	2019
Who	IGRAC, in cooperation with GTN-H and TOPC
Performance indicator	Reports to UNESCO IHP and WMO CHy on the completeness of the GTN-GW record held in GGMS, including the number of records in, and nations submitting data to, GGMS; web-based delivery of products to the community
Annual cost	US$ 1–10 million

Complete the establishment of a full-scale GGMS as a web portal for all GTN-GW datasets; continue existing observations and deliver readily available data and products to the information system

Rapporteur: (Stephan Dietrich)

I will contact the responsible contact within GTN-H for leading the rapport.

claudiaruzvclaudiaruzv :
This GGMS web portal is actually the previous version of GGMN (https://ggmn.un-igrac.org/), isn't it? at least according to this document... http://www.fao.org/docrep/pdf/011/i0197e/i0197e07.pdf

Action T14: Operational groundwater monitoring from gravity measurements	
Action	Develop an operational groundwater product, based on satellite observations
Benefit	Global, consistent and verified datasets available to users
Time frame	2019
Who	Satellite agencies, CEOS, CGMS
Performance indicator	Reports to UNESCO IHP and WMO CHy on the completeness of the GTN-GW record held in GGMS, including the number of records in, and nations submitting data to, GGMS; web-based delivery of products to the community.
Annual Cost	US$ 1–10 million

sdietrich :

I will contact the responsible contact within GTN-H for leading the rapport.

Action T15: Satellite soil-moisture data records	
Action	Regularly update individual microwave sensor (SMOS, SMAP, ASCAT, AMSR-E …) soil-moisture data records, including the subsidiary variables (freeze/thaw, surface inundation, vegetation optical depth, root-zone soil moisture)
Benefit	Time series of data to identify trends over time
Time frame	Continuing
Who	Space agencies (ESA, EUMETSAT, NASA, NOAA, JAXA …) and Earth observation service providers
Performance indicator	Availability of free and open global soil-moisture data records for individual microwave missions
Annual cost	US$ 10–30 million

Wwagner: EUMETSAT H-SAF regularly releases re-processed soil moisture data records referred to as "Surface Soil Moisture Metop ASCAT Data Record Time Series". See

http://hsaf.meteoam.it/description-h25-h108-h111.php

Action T16: Multi-satellite, soil-moisture data services	
Action	Regularly update of merged multi-sensor, soil-moisture data records, including the subsidiary variables (freeze/thaw, surface inundation, vegetation optical depth, root-zone soil moisture)
Benefit	High-quality, soil moisture CDR for users
Time frame	Continuing
Who	Copernicus, NOAA, Earth observation data providers
Performance indicator	Availability of free and open merged multi-sensor data records (merged passive, merged active and merged active-passive data)
Annual cost	US$ 1–10 million

Action T17: International soil-moisture network	
Action	Operate, provide user services and expand the International Soil Moisture Network (ISMN), which is part of the GTN-H.
Benefit	Coordinated in situ soil moisture data for users and calibration/validation
Time frame	Continuing
Who	Vienna Technical University, supported by national data providers, ESA, GEWEX, CEOS and GEO
Performance indicator	Availability of harmonized and quality-controlled in situ soil-moisture data provided by network operators to ISMN
Annual cost	US$ 100 000–1 million (includes only central services of the ISMN data centre)

Action T18: Regional high-resolution soil-moisture data record	
Action	Develop high-resolution soil-moisture data records for climate change adaptation and mitigation by exploiting microwave and thermal remote-sensing data
Benefit	Availability of data suitable for adaptation
Time frame	2017–2020
Who	NASA Soil Moisture Active-Passive Programme, ESA Climate Change Initiative, Copernicus Evolution Activities in cooperation with identified universities and research organizations
Performance indicator	Public releases of experimental multi-year (> 10 years) high-resolution, soil-moisture data records
Annual cost	US$ 10–30 million

Wwagner: A beta version of the SMAP/Sentinel-1 L2 Radiometer/Radar 30-Second Scene 3 km EASE-Grid Soil Moisture data set has become available at the NASA National Snow and Ice Data Center Distributed Active Archive Center (NSIDC DAAC)

https://nsidc.org/the-drift/data-update/high-resolution-smapsentinel-1-soil-moisture-data-available/

Action T19: Maintain and extend the in situ mass balance network	
Action	Maintain and extend the in situ mass balance network, especially within developing countries and High Mountain Asia (Himalaya, Karakorum, Pamir) (e.g. using capacity-building and twinning programmes)
Benefit	Maintain a critical climate record
Time frame	Ongoing
Who	Research community, national institutions and agencies
Performance indicator	Number of observation series submitted to WGMS
Annual cost	US$ 100 000–1 million

Mzemp:

Ongoing task undertaken within the framework of GTN-G by WGMS.

Action T20: Improve the funding situation for international glacier data centres	
Action	Improve the funding situation for international glacier data centres and services as well as for long-term glacier-monitoring programmes. Integrated and international availability of funding for sustaining programme, expecting also private sector contributions
Benefit	Secure long-term monitoring and data availability
Time frame	2020
Who	National and international funding agencies
Performance indicator	Resources dedicated to glacier-database management at WGMS and NSIDC; number of reference glaciers with more than 30 years of continued observations
Annual cost	US$ 1–10 million

Mzemp:

Progress: WGMS get long-term core funding from Swiss government.

Progress: NSIDC got some project money dedicated to the GLIMS database.

Action T21:	Encourage and enforce research projects to make their ECV-relevant observations available through the dedicated international data centres
Action	Encourage and enforce research projects to make their ECV-relevant observations available through the dedicated international data centres (e.g. through dedicated budget lines and the use of digital object identifiers for datasets).
Benefit	Open and long-term availability of data for users
Time frame	Ongoing
Who	National funding agencies
Performance indicator	Number of datasets submitted to dedicated international data centres
Annual cost	US$ 100 000–1 million

mzemp :

Progress: Swiss National Science Foundation introduced a mandatory Data Management Plan with dedicated funding (up to 10 KCHF) in 2017: every project must declare how the research data will remain available at international data repositories.

Action T22:	Global glacier inventory
Action	Finalize the completion of a global reference inventory for glaciers and increase its data quality (e.g. outline, time stamp) and data richness (e.g. attribute fields, hypsometry)
Benefit	Improved data quality on glaciers
Time frame	2020
Who	NSIDC and WGMS with GLIMS research community and space agencies
Performance indicator	Data coverage in GLIMS database
Annual cost	US$ 100 000–1 million

mzemp :

Progress:

ongoing effort of GLIMS community: http://www.glims.org

IACS Working Group working on this task: http://www.cryosphericsciences.org/wg_randGlacierInv.html

above products are brokered to C3S Climate Data Store: https://climate.copernicus.eu/

Action T23:	Multi-decadal glacier inventories
Action	Continue to produce and compile repeat inventories at multi-decadal timescale
Benefit	Extend the time series of glacier information
Time frame	Ongoing
Who	NSIDC and WGMS with GLIMS research community and space agencies.
Performance indicator	Data coverage in GLIMS database
Annual cost	US$ 1–10 million

Action T24:	Allocate additional resources to extend the geodetic dataset

Action	Allocate additional resources to extend the geodetic dataset at national, regional and global levels: decadal elevation change can potentially be computed for thousands of glaciers from air- and spaceborne sensors
Benefit	Improved accuracy of glacier change
Time frame	Ongoing
Who	WGMS with research community and space agencies
Performance indicator	Data coverage in WGMS database
Annual cost	US$ 30–100 million

Mzemp:

the WGMS started to compile and produce geodetic elevation changes for several thousand glaciers within the Copernicus Climate Change Service: http://wgms.ch/boost-remote-sensing-data/

The WGMS encouraged its network of Principal Investigators to participate in a first scientific exploitation of the global DEM product of the TanDEM-X mission for glacier monitoring: http://wgms.ch/boost-remote-sensing-data/

In coordination with LEGOS and the WGMS, glaciologists can acquire stereo data of selected benchmark glaciers at the end of the melt season: http://wgms.ch/boost-remote-sensing-data/

Action T25: Extend the glacier-front variation dataset both in space and in time	
Action	Extend the glacier-front variation dataset both in space and back in time, using remote-sensing, in situ observations and reconstruction methods
Benefit	Understanding long-term trends in glacier extent (mass trends need additional information)
Time frame	Ongoing
Who	WGMS with research community and space agencies
Performance indicator	Data coverage in WGMS database
Annual Cost	US$ 10 000–100 000

Mzemp:

Progress:

WGMS has annual calls-for-data to compile glacier front variation data from direct observations.

The WGMS has extended its database to store glacier front variations from reconstructions (e.g. historical & pictorial sources, dendrochronology)

Action T26: Glacier observing sites

Action	Maintain current glacier-observing sites and add additional sites and infrastructure in data-sparse regions, including South America, Africa, the Himalayas, the Karakoram and Pamir mountain ranges, and New Zealand; attribute quality levels to long-term mass-balance measurements; improve satellite-based glacier inventories in key areas
Benefit	Sustained global monitoring to understand global trends
Time frame	Continuing, new sites by 2017
Who	Parties' national services and agencies coordinated by GTN-G partners, WGMS, GLIMS and NSIDC
Performance indicator	Completeness of database held at NSIDC from WGMS and GLIMS
Annual cost	US$ 10–30 million

Mzemp:

Ongoing need for research & monitoring activities, ideally coordinated by the GTN-G bodies (i.e. WGMS, NSIDC, GLIMS).

Action T27:	Observations of glacier velocities
Action	Encourage observations and reporting of glacier velocities
Benefit	Improve understanding of glacier dynamics and mass loss
Time frame	Starting 2017
Who	GTN-G partners, WGMS, GLIMS and NSIDC
Performance indicator	Completeness of database held at NSIDC from WGMS and GLIMS
Annual cost	US$ 100 000–1 million

Mzemp:

Progress:

ESA Glaciers_cci produced glacier velocities for several regions: http://www.esa-glaciers-cci.org/
Global Land Ice Velocity Extraction from Landsat 8: https://nsidc.org/data/golive

Action T28:	Snow-cover and snowfall observing sites
Action	Strengthen and maintain existing snow-cover and snowfall observing sites, provide clear and unambiguous instructons; ensure that sites exchange snow data internationally; establish global monitoring of those data over the GTS; and recover historical data; ensure reporting includes reports of zero cover.
Benefit	Improved understanding of changes in global snow
Time frame	Continuing; receipt of 90% of snow measurements at international data centres
Who	NMHSs and research agencies, in cooperation with WMO-GCW and WCRP and with advice from TOPC, AOPC and tGTN-H
Performance indicator	Data submission to national centres such as NSIDC and world data services
Annual cost	US$ 1–10 million

mzemp :

Comment: important input & control factor for other ECVs such as GLACIERS, PERMAFROST, SEA ICE, etc.

Comment: to be coordinated with atmospheric precipitation ECV

Action T29:	Integrated analyses of snow
Action	Obtain integrated analyses of snow over both hemispheres
Benefit	Improved understanding of changes in global snow
Time frame	Continuous
Who	Space and research agencies in cooperation with WMO-GCW and WCRP-CliC with advice from TOPC, AOPC and IACS
Performance indicator	Availability of snow-cover products for both hemispheres
Annual cost	US$ 1–10 million

pmathieu :

what would be the role of reanalysis in generating ECV? vs simple fusion techniques?

Action T30:	Ice-sheet measurements

Action	Ensure continuity of in situ ice-sheet measurements and field experiments for improved understanding of processes and for the better assessment of mass-loss changes
Benefit	Robust data on trends in ice-sheet changes
Time frame	Ongoing
Who	Parties, working with WCRP-CliC, IACS and SCAR
Performance indicator	Integrated assessment of ice sheet change supported by verifying observations.
Annual cost	US$ 10–30 million

Mzemp:

Ongoing action for the research community, still not well coordinated.

Progress in Greenland:

Danish Programme for the monitoring of the Greenland Ice Sheet: https://www.promice.dk/home.html

Swiss Camp monitoring programme: ...

Progress in Antarctica:

CRYOBSCLIM/GLACIOCLIM SurfAce Mass Balance of Antarctica Observatory: http://pp.ige-grenoble.fr/pageperso/favier/glacioclim-samba.php

Action T31:	**Ice-sheet model improvement**
Action	Research into ice-sheet model improvement to assess future sea-level rise; improving knowledge and modelling of ice–ocean interaction, calving ice-mass discharge
Benefit	Improved sea-level rise forecasting
Time frame	International initiative to assess local and global sea-level rise and variability
Who	WCRP-CliC sea-level cross-cut, IACS and SCAR
Performance indicator	Reduction of sea-level rise uncertainty in future climate prediction from ice-sheet contributions
Annual cost	US$ 1–10 million (mainly by Annex-I Parties)

mzemp :

Progress Antarctica:

Ice Sheet Mass Balance and Sea Level (ISMASS): https://www.scar.org/science/ismass/ismass/

Action T32:	**Continuity of laser, altimetry and gravity satellite missions**
Action	Ensure continuity of laser, altimetry and gravity satellite missions adequate to monitor ice masses over decadal timeframes
Benefit	Sustain ice-sheet monitoring into the future
Time frame	New sensors to be launched in 10-30 years
Who	Space agencies, in cooperation with WCRP-CliC and TOPC
Performance indicator	Appropriate follow-on missions agreed
Annual cost	US$ 30–100 million

Action T33: Standards and practices for permafrost	
Action	Refine and implement international observing standards and practices for permafrost and combine with environmental variable measurements; establish national data centres
Benefit	Consistent and comparable global observations
Time frame	Complete by 2018
Who	Parties' national services/research institutions and IPA
Performance indicator	Implementation of guidelines and establishment of national centres
Annual cost	US$ 100 000–1 million

mzemp :

Progress:

standards developed by various projects (e.g. CALM protocols for active layer thickness, PACE21 requirements for boreholes) and will be implemented by GTN-P: https://gtnp.arcticportal.org/

Action T34: Mapping of seasonal soil freeze/thaw	
Action	Implement operational mapping of seasonal soil freeze/thaw through an international initiative for monitoring seasonally frozen ground in non-permafrost regions and active layer freeze/thaw in permafrost regions
Benefit	Improved understanding of changes in biosphere and carbon cycle
Time frame	Complete by 2020
Who	Parties, space agencies, national services and NSIDC, with guidance from IPA, the IGOS Cryosphere Theme team, and WMO-GCW
Performance indicator	Number and quality of mapping products published.
Annual cost	US$ 1–10 million

mzemp : No progress in view. No coordinating network. Guidance need to be (re)defined.

Action T35: Ensure the consistency of the various radiant energy fluxes	
Action	The the various radiant energy fluxes (e.g. surface albedo and FAPAR) derived from remote-sensing observation, and their compatibility with the specific requirements of the models, especially in the context of climate change studies; fire and surface albedo, especially in the context of climate change studies
Benefit	Improved data leading to improved model predictions and understanding of changes in biosphere
Time frame	2020
Who	CEOS WG Cal/Val, TOPC observers, CEOS/CGMS WG Climate
Performance indicator	Documented system to ensure consistency; reports demonstrating consistency
Annual cost	U US$ 100 000–1 million

Mfmccabe:

GEWEX-GDAP (Data and Assessments Panel) have had some efforts to do this in terms of producing a consistent global water and energy product (based around SRB). The GEWEX-LandFlux project "tried" to do this in developing the global surface heat flux product - but with varying success (i.e. the albedo, LAI, FAPAR etc were key challenges).

nadinegobnadinegob :
Methodology to check the temporal and spatial consistencies between fire and albedo (using several products) was developed.
Impacts on radiative forcing have been studied, too. Publication is on review. This exercice will be redone within C3S F4P platform. Note that uncertainties impact the overall results.

Same for FAPAR and LAI. Three sources of products were studied.

C3S has ensured in its call for consistency between surface albedo, FAPAR and LAI.

Pmathieupmathieu:
please make the case for joint retrieval to ensure radiative consistency with QUANTIFY EOLDAS framework

Action T36: Climate change indicators for adaptation	
Action	Establish climate change indicators for adaptation issues using land ECVs at high resolution
Benefit	Inputs into adaptation planning, damage limitation and risk assessments
Time frame	Initial products by 2018; ongoing development and improvement
Who	GCOS, GCOS Science panels, WCRP, GFCS
Performance indicator	Availability of indicators
Annual cost	US$ 100 000–1 million

Action T37: Quality of ground-based reference sites for FAPAR and LAI	
Action	Improve the quality and number of ground-based reference sites for FAPAR and LAI; agree minimum measurement standards and protocols; conduct systematic and comprehensive evaluation of ground-based measurements for building a reference sites network
Benefit	Ensure quality assurance of LAI and FAPAR products
Time frame	Network operational by 2020
Who	Parties' national and regional research centres, in cooperation with space agencies and Copernicus coordinated by CEOS WGCV, GCOS and TOPC
Performance indicator	Data available
Annual cost	US$ 1–10 million

nadinegob: Within CEOS LPV (ask them), protocol is on going.
CEOS LPV proposes super-sites (add link)

Copernicus GBOV project starts to provide more in-situ data (add link when available)

The development platform of the Ground-Based Observations for Validation (GBOV) of Copernicus Global Land Products can be found here: http://gbov.copernicus.acri.fr/
The public release of data is foreseen before end the year and gradually the number o fsites will increase.

Action T38: Improve snow and ice albedo products	
Action	Improve quality of snow (ice and sea ice) albedo products
Benefit	Improve consistency of datasets
Time frame	2018
Who	Space agencies and Copernicus coordinated through CEOS WGCV LPV, WMO Space Pprogramme, with advice from GCOS and TOPC
Performance indicator	Product available
Annual cost	US$ 100 000–1 million

Action T39: Improve in situ albedo measurements	
Action	Improve quality of available in situ validation measurements and collocated albedo products, as well as BHR factors and measures of surface anisotropy from all space agencies generating such products; promote benchmarking activities to assess the reliability of albedo products
Benefit	Improved calibration and validation
Time frame	Full benchmarking/intercomparison by 2012
Who	BSRN and spatially representative FLUXNET sites, space agencies in cooperation with CEOS WGCV LPV
Performance indicator	Data available to analysis centres
Annual cost	US$ 1–10 million

nadinegob :
Theoretical 3D-RT based study shows how to improve the ground-based albedo quality.

https://www.sciencedirect.com/science/article/pii/S0022407316300085

See GBOV web site

Action T40: Production of climate data records for LAI, FAPAR and Albedo	
Action	Operationalize the generation of • 10-day and monthly FAPAR and LAI products as gridded global products at 5 km spatial resolution over time periods as long as possible; • 10-day FAPAR and LAI products at 50 m spatial resolution; • Daily (for full characterization of rapidly greening and senescing vegetation, particularly over higher latitudes with the rapid changes due to snowfall and snowmelt), 10-day and monthly surface albedo products from a range of sensors using both archived and current Earth observation systems as gridded global products at 1 km to 5 km spatial resolution of over time periods as long as possible
Benefit	Provide longer time records for climate monitoring
Time frame	2020
Who	Space agencies, Copernicus and SCOPE-CM coordinated through CEOS WGCV LPV
Performance indicator	Operational data providers accept the charge of generating, maintaining and distributing global physically consistent ECV products
Annual cost	US$ 100 000–1 million

Action T41:	Evaluate LAI, FAPAR and Albedo
Action	Promote benchmarking activities to assess reliability of FAPAR and LAI products, taking into account their intrinsic definition and accuracy assessment against fiducial ground references and evaluate the Albedo products with high-quality tower data from spatially representative sites
Benefit	Improved accuracy of data
Timeframe	Evaluation by 2019
Who	Space agencies and Copernicus in relation with CEOS WGCV, GCOS/TOPC
Performance indicator	Publish results
Benefit	Recommendations after gap analysis on further actions for improving algorithms
Annual cost	US$ 10 000–100 000

Action T42:	Land-surface temperature: in situ protocols
Action	Promote standardized data protocols for in situ LST and support the CEOS-LPV group in development of a consistent approach to data validation, taking its LST Validation Protocol as a baseline
Benefits	LST datasets will be more accessible to users, encouraging user uptake of more than one LST dataset. This will lead to better characterisation of uncertainties and inter-dataset variability.
Time frame	Network concept and approach by 2017; implementation by 2018
Who	Parties' national services and research agencies, space data providers, GOFC-GOLD, NASA LCLUC, TOPC, CEOS WGCV/LPV
Performance indicator	Availability of protocols and evidence of their use.
Annual cost	US$ 1 000 –10 000

Action T43:	Production of land-surface temperature datasets
Action	Continue the production of global LST datasets, ensuring consistency between products produced from different sensors and by different groups
Benefits	Make available long time series of LST datasets in consistent formats, enabling more widespread use of LST for climate applications
Time frame	Continual
Who	Space agencies
Performance indicator	Up-to-date production of global LST datasets
Annual cost	US$ 10 000 –100 000

Action T44:	Reprocessing land-surface temperature
Action	Reprocess existing datasets of LST to generate a consistent long-term time series of global LST; in particular, reprocess archives of low Earth orbit and geostationary LST observations in a consistent manner and to community-agreed data formats
Benefits	Make available long time series
Time frame	Network concept and approach by 2017; implementation by 2018
Who	Parties' national services and research agencies, space data providers, GOFC-GOLD, NASA LCLUC, TOPC, CEOS WGCV/LPV
Performance indicator	Availability of long time series of LST datasets
Annual cost	US$ 100 000–1 million

Action T45:	Land-surface temperature in situ network expansion
Action	Expand the in situ network of permanent, high-quality IR radiometers for dedicated LST validation
Benefits	LST datasets better validated and over more land-surface types; independent validation of stated accuracies providing credibility to satellite LST products
Time frame	Network concept and approach by 2017; implementation by 2018
Who	Parties' national services and research agencies, space data providers, GOFC-GOLD, NASA LCLUC, TOPC, CEOS WGCV/LPV, ILSTE
Performance indicator	Establishment of a comprehensive network of ground sites with high-quality in situ measurements suitable for validating the different sensors; results from in situ radiometer intercomparison exercises
Annual cost	US$ 1–10 million (10-20 sites at US$ 100 000 per site)

Action T46:	Land-surface temperature radiometric calibration
Action	Radiometric calibration intercomparisons and uncertainties for LST sensors
Benefits	LST datasets better calibrated and over all land-surface types for different satellite sensors; independent calibration providing credibility and traceability of data and uncertainties
Time frame	Network concept and approach by 2017; implementation by 2018
Who	Coordinated by CEOS WGCV Infrared and Visible Optical Sensors subgroup/GSICS and supported by space agencies
Performance indicator	ECV generators taking into account radiometric calibration uncertainties, ideally with calibrations being referenced to a common framework
Annual Cost	US$ 1–10 million

Action T47:	Land-cover experts
Action	Maintain and strengthen a global network of land-cover/land-use experts to: develop and update an independent, very high spatial-resolution reference dataset for global land-cover map accuracy assessment;and facilitate access to land-use and management information to support the development of global-scale land-use products
Benefits	For GLC map developers, GLC map users
Time frame	Network concept and approach by 2017; implementation by 2018
Who	GOFC-GOLD, CEOS WGCV/LPV, Parties' national services and research agencies, space data providers, NASA LCLUC, TOPC
Performance indicator	Global LC map developers using the reference data developed by the operational network
Annual cost	US$ 100 000–1 million

c5hema :

A reference data portal containing many published/historical land cover reference/validation data have been assessed and made available (http://www.gofcgold.wur.nl/sites/gofcgold_refdataportal.php). More consistent reference data is collected by the EC Copernicus global land monitoring service and will be made available in the future as annual operational data stream (https://land.copernicus.eu/global/products/lc).

Action T48:	Annual land-cover products
Action	Generate annual land-cover products over key regions that allow change assessment across time (including for the six IPCC AFOLU land categories) at 10 m–30 m spatial resolutions, according to internationally agreed standards and accompanied by statistical descriptions of their accuracy
Benefits	For mitigation and adaptation communities
Time frame	2017 and beyond
Who	Space agencies, GOFC-GOLD, Copernicus Land Service, USGS, University of Maryland (UMD)-GoogleEarth
Performance indicator	Product delivered and used by a large community; use of standard approaches for validation and uncertainty metrics
Annual cost	US$ 1–10 million

c5hema :

Several pre-operational efforts are producing global and regional land cover datasets using Landsat and increasingly Sentinel data. They include UMD annual global tree cover gains and losses, China's 30m global land cover, and ESA/UCL first 20 m prototype land cover map for Africa. None of them allow for a global change assessments at 30 m resolution for all IPCC land use categories and also the independent validation for both high resolution land cover and changes is just starting.

Action T49:	Land-cover change
Action	Generate global-scale land-cover products with an annual frequency and long-term records that allow change assessment across time (including as much as possible for the six IPCC AFOLU land categories), at resolutions between 250 m and 1 km, according to internationally agreed standards and accompanied by statistical descriptions of their accuracy
Benefits	To climate change modellers, others
Time frame	2017 and beyond
Who	Space agencies, research institutes, GOFC-GOLD, Copernicus Land Service
Performance indicator	Product delivered and used; use of standard approaches for validation and uncertainty metrics
Annual cost	US$ 1–10 million

c5hema :

The ESA CCI land cover project has generated and made available a long-time series of land cover changes (https://www.esa-landcover-cci.org/) for the six IPCC categories. No validation of the changes has been done so far.

Action T50:	Land-cover community consensus
Action	Develop a community consensus strategy and priorities for monitoring to include information on land management in current land-cover datasets and start collecting relevant datasets and observations, building on ongoing activities
Benefits	To climate change modellers, mitigation and adaptation user communities
Time frame	Concept and approach by 2017; start Implementation by 2018
Who	Parties' national services and research agencies, space agencies, GOFC-GOLD, NASA LCLUC, TOPC, UMD-GoogleEarth, CEOS, ESA, USGS, GOFC-GOLD, FAO, GEO
Performance indicator	Product delivered and used
Annual cost	US$ 100 000–1 million

c5hema :

Two community-consensus benchmark scientific papers have been published to clarify and status and needs to include land use and land management information earth system and integrated assessment models:

Erb, Karl-Heinz ; Luyssaert, Sebastiaan ; Meyfroidt, Patrick ; Pongratz, Julia ; Don, Axel ; Kloster, Silvia ; Kuemmerle, Tobias ; Fetzel, Tamara ; Fuchs, Richard ; Herold, Martin ; Haberl, Helmut ; Jones, Chris D. ; Marín-Spiotta, Erika ; McCallum, Ian ; Robertson, Eddy ; Seufert, Verena ; Fritz, Steffen ; Valade, Aude ; Wiltshire, Andrew ; Dolman, Albertus J. (2017). Land management: data availability and process understanding for global change studies, Global Change Biology 23 (2). - p. 512 - 533.

Pongratz, Julia ; Dolman, Han ; Don, Axel ; Erb, Karl Heinz ; Fuchs, Richard ; Herold, Martin ; Jones, Chris ; Kuemmerle, Tobias ; Luyssaert, Sebastiaan ; Meyfroidt, Patrick ; Naudts, Kim (2018). Models meet data : Challenges and opportunities in implementing land management in Earth system models, Global Change Biology 24 (4). - p. 1470 - 1487.

They can be used as reference document to start collecting data (for modeling purposes) and identify further gaps and observational challenges.

Action T51: Deforestation	
Action	Develop yearly deforestation (forest clearing) and degradation (partial clearing) for key regions that allow change assessment across time at 10 m–30 m spatial resolutions, according to internationally agreed definitions.
Benefits	To provide annual monitoring of deforestation and forest degradation to support management and reporting
Time frame	Concept and approach by 2017; implementation by 2018
Who	Parties' national services and research agencies, space agencies, GOFC-GOLD, NASA LCLUC, UMD-GoogleEarth, TOPC.
Performance indicator	Indicators-based standard validation approach for change of forest cover and attributions associated with deforestation and degradation; product delivered and used
Annual cost	US$ 100 000–1 million

c5hema:

UMD/GLAD are producing annual global tree cover loss and gain data using Landsat data 2000-16). There is inconsistency with the forest and deforestation definition used by FAO FRA. Some sample-based approach (FAO/JRC) has been used to map tropical deforestation and follow up land use but has not recently been updated.

Many countries involved in REDD+ are now capable of producing forest area change estimates at annual or bi-annual level using satellite time series for reporting using the IPCC GHG inventory good practice guidelines. A related method and guidance document has been developed by the Global Forest Observation Initiative (GFOI) that is now widely used by countries (www.gfoi.org/methods-guidance/).

Action T52: Collaboration on above ground biomass	
Action	Encourage inter-agency collaboration on developing optimal methods to combine biomass estimates from current and upcoming missions (e.g. ESA BIOMASS, NASA GEDI and NASA-ISRO NiSAR, JAXA PALSAR, CONAE SAOCOM)
Benefits	Reduced error, cross-validation, combining strengths of different sensors in different biomass ranges
Time frame	Most key missions are expected to be in orbit between 2016 and 2020
Who	ESA, NASA, JAXA, NASA-ISRO, CONAE
Performance indicator	A strategy to combine biomass estimates from different sensors, together with algorithms and processing methods
Annual cost	US$ 100 000–1 million

c5hema:

A recent meeting at the International Space Science Institute (ISSI, http://www.issibern.ch/workshops/biomass/) has started the process for collaboration and inter-calibration. A special issue in a scientific journal is in preparation.

Action T53: Above-ground biomass validation strategies	
Action	Encourage inter-agency collaboration to develop validation strategies for upcoming missions aimed at measuring biomass (e.g. ESA BIOMASS, NASA GEDI and NASA-ISRO NiSAR), to include combined use of in situ and airborne lidar biomass measurements
Benefits	Potential to produce more comprehensive validation of biomass estimates by cost-sharing. Greater consistency between biomass estimates from different sensors because of assessment against common reference data
Time frame	From now until the operational phase of the various sensors (2016–2022).
Who	ESA, NASA, JAXA, NASA-ISRO, CONAE
Performance indicator	Formal agreement between agencies on a strategy for joint gathering and sharing of validation data, together with funding of specific elements of the overall set of validation data
Annual cost	US$ 10 000–100 000

c5hema :

A recent meeting at the International Space Science Institute (ISSI, http://www.issibern.ch/workshops/biomass/) has started the process for collaboration and inter-calibration. A special issue in a scientific journal is in preparation.

The CEOS LPV has established a team focusing on biomass and the effort to develop a validation protocol has started.

Action T54: Above-ground biomass validation sites	
Action	Develop a set of validation sites covering the major forest types, especially in the tropics, at which high-quality biomass estimations can be made, using standard protocols developed from ground measurements or airborne lidar techniques
Benefits	Essential to give confidence in satellite-derived biomass estimates at global scale
Time frame	From now up to the operational phase of the various sensors (2018–2022)
Who	Space agencies working with key in situ networks (e.g. RainFor, Afritron, the Smithsonian Center for Tropical Forest Science), GEO-GFOI
Performance indicator	Establishment of a comprehensive network of ground sites with high-quality, in situ biomass estimates with uncertainty assessments suitable for validating the different sensors
Annual cost	US$ 30–100 million (50 tropical sites covering all forest types: US$ 20 million); estimate for temperate and boreal sites not yet formulated

c5hema:

The in-situ community from tropical biomass networks (i.e. Rainfor, Afritron, 2ndFor etc.) have proposed a framework to develop a set of validation sites. A first effort has resulted in the FOS network and standardized some available in-situ datasets (http://forest-observation-system.net/).

The GEDI team is putting together a comprehensive calibration database to be ready for GEDI operation in 2018/19.

The ESA Globbiomass project has putting together a comprehensive global biomass validation database to independently validate the Globbiomass 2010 product. Efforts continue as part if ESA's Biomass-CCI with close involvement of the in-situ community.

Action T55: Above-ground biomass data access	
Action	Promote access to well-calibrated and validated regional- and national-scale biomass maps that are increasingly being produced from airborne lidar.
Benefits	Greatly extends the representativeness of data available for validating satellite-derived biomass data, since a much greater range of land types and forest conditions will be covered
Time frame	From now until the operational phase of the various sensors (2016–2022)
Who	GEO-GFOI, other national and international bodies producing biomass maps
Performance indicator	Availability of multiple regional- to country-scale maps of biomass derived from airborne lidar; use of standard protocols for uncertainty assessment of lidar estimation of biomass
Annual cost	US$ 10 000–100 000 (does not include monitoring costs)

c5hema: In-situ biomass reference remain largely inaccessible for the larger biomass mappign community. A first effort supported by ESA has resulted in the FOS network and standardized some available in-situ datasets (http://forest-observation-system.net/).

The GEDI team is putting together a comprehensive calibration database to be ready for GEDI operation in 2018/19.

The ESA Globbiomass project has putting together a comprehensive global biomass validation database to independently validate the Globbiomass 2010 product. Efforts continue as part if ESA's Biomass-CCI with close involvement of the in-situ community.

Several initiatives have been producing regional biomass maps and data bases that have been made available (i.e. Global Forest Watch, www.globalforestwatch.org, ESA Globbiomass project globbiomass.org)

Australia has put together a comprehensive regional biomass database (www.tern.org.au)

Action T56:	Above-ground biomass: forest inventories
Action	Improve access to high-quality forest inventories, especially in the tropics, including those developed for research purposes and REDD+
Benefits	Extends the data available for validating satellite-derived biomass data
Time frame	From now until the operational phase of the various sensors (2016–2022)
Who	GEO-GFOI, other national and international bodies producing or funding forest inventories
Performance indicator	Access to databases of georeferenced biomass measurements derived from ground measurements for forest-inventory purposes
Annual cost	US$ 10 000–100 000

c5hema :

The GFOI R&D coordination team in collaboration with FAO and the Worldbank FCPF are working on a framework to share NFI data on aggregate level for the purpose of updating the biomass Tier 1 defaults the 2019 refinement of the IPCC GPG. This effort could be seen as a pilot to see if and how an interaction between NFI efforts in the tropics and biomass mapping from space can start to exchange and integrate more. GFOI is a central body to establish such a mechanism.

Action T57:	Soil carbon: carbon mapping
Action	Cooperate with the soil-carbon mapping exercises to advocate accurate maps of soil carbon
Benefit	Improved data accuracy
Time frame	Ongoing
Who	TOPC and GCOS
Performance indicator	Improved maps
Annual cost	US$1 000–10 000

Action T58:	Soil-carbon change
Action	Encourage flux sites to measure soil carbon at five-year intervals and record soil-management activities; use this to supplement long-term experiments that are monitoring soil carbon.
Benefit	Improved in situ observations will improve accuracy.
Time frame	Ongoing
Who	TOPC and GCOS
Performance indicator	Number of flux sites making measurements
Annual cost	US$10 000–100 000

Action T59:	Soil carbon – histosols
Action	Provide global maps of the extent of histosols (peatlands, wetlands and permafrost) and their depth
Benefit	Improve understanding of carbon pools at risk from climate change
Time frame	Ongoing
Who	Research communities, ISRIC, HWSD and the Global Soil Map
Performance indicator	Availability of maps
Annual cost	US$ 10 000–100 000

Action T60:	Historic fire data
Action	Reanalyse the historical fire-disturbance satellite data (1982 to present)
Benefits	Climate-modelling communities
Time frame	By 2020
Who	Space agencies, working with research groups coordinated by GOFC-GOLD-Fire By 2020
Performance indicator	Establishment of a consistent dataset, including the globally available AVHRR data record
Annual cost	US$ 1–10 million

Ktansey:

:| MORE PROGRESS NEEDED

There is some activity on this topic by research organisations and government funded organisations. Kevin Tansey invites experts to contribute to discussion around this topic and provide evidence that this work is being undertaken and progress against this action being made.

Action T61:	Operational global burned area and fire radiative power
Action	Continue the production of operational, global burned area active fire (with associated FRP) products, with metadata and uncertainty characterizations that meet threshold requirements and have necessary product back-up to ensure operational delivery of products to users.
Benefits	Climate-modelling communities, space agencies, civil protection services, fire managers, other users
Time frame	Continuous
Who	Space agencies, Copernicus Global Land Service, Copernicus Atmospheric Monitoring Service, GOFC-GOLD
Performance indicator	Availability of products that meet user needs
Annual cost	US$ 1–10 million

Ktansey:

:smile: MODERATE PROGRESS

Production of operational fire products continue at the global scale (with a number of other products available for selected regions and limited time periods) . These include:
Burned Area:MODIS (MCD64); Copernicus CGLS; ESA CCI
FRP: Copernicus CAMS that is assimilated into the GFAS system; NASA MODFIRE;
Active Fire Data come from a number of sources including from MODIS, SLSTR, VIIRS and sensors in geo-stationary orbit.

It is less clear on the status of these products with regard to the availability of supporting information on metadata and uncertainty characterization. Kevin Tansey invites experts to contribute to discussion around this topic and provide evidence work on uncertainty characterization is on-going, the definitions that are in use and how this information is embedded or made explicit in products.

Action T62:	Fire maps
Action	Consistently map global burned area at < 100m resolution on a near-daily basis from combinations of satellite products (Sentinel-2, Landsat, Sentinel-1, PROBA); work towards deriving consistent measures of fire severity, fire type, fuel moisture and related plant-fuel parameters
Benefits	Climate-modelling communities , space agencies, civil protection services, fire managers, other users
Time frame	By 2020
Who	Space agencies, research organizations, international organizations in collaboration with GOFC-GOLD-Fire
Performance indicator	Availability of data and products
Annual cost	US$ 1–10 million

Ktansey:

$:| MORE PROGRESS NEEDED

Kevin Tansey invites experts to contribute to discussion around this topic and provide evidence that this work is being undertaken and progress against this action being made.

Action T63:	Fire validation
Action	Continuation of validation activity around the detection of fire-disturbed areas from satellites to show that threshold requirements are being met; work to reduce the errors of commission and omission; provide better than existing uncertainty characterization of fire-disturbance products.
Benefits	Climate-modelling communities.
Time frame	Continuous
Who	Space agencies and research organizations, supported by CEOS LPV
Performance indicator	Publication of temporal accuracy
Annual cost	US$ 1–10 million

Ktansey:
:D VERY GOOD PROGRESS

There has been a strong development against this action. Work funded by the European Space Agency and the Copernicus programmes has supported the production of a statistically robust sampling framework for the collection of reference data from higher resolution sensors (Landsat) to validate global burned area products. The reference data set comprises at least 100 image pairs for each year covering the period 2003 to 2014. Based on this data set that stability of products can be established. The methodology for deriving the reference data sample and the metrics of reporting accuracy has been published in the peer-reviewed literature. The results will give insight into how algorithms and detection methods can be improved to reduce uncertainty in future iterations.

The validation of FRP is in development and Kevin Tansey invites experts to contribute to discussion around this topic and provide evidence that this work is being undertaken and progress against this action being made.

Action T64:	Fire disturbance model development
Action	Continuation of joint projects between research groups involved in the development of atmospheric transport models, dynamic vegetation models and GHG emission models, tthe climate-modelling and transport-modelling community and those involved in the continual algorithm development, validation and uncertainty characterization of fire-disturbance products from satellite data (the Earth observation and modelling community); contribute to better understanding of fire risk and fire-risk modelling
Benefits	Climate-modelling communities, Copernicus Programme
Time frame	Continuous
Who	Space agencies (NASA, ESA, etc.), inter-agency bodies (GOFC-GOLD, CEOS, ECMWF, Meteosat, etc.), Copernicus Global Land Service, Copernicus Atmospheric Monitoring Service, GOFC-GOLD
Performance indicator	Projects that engage climate and atmospheric transport modellers and product-development community
Annual cost	US$ 1–10 million

ktansey :
:) MODERATE PROGRESS

There is consolidated activity on this action within the ESA CCI project. There is further use of Fire Disturbance Products in the GFAS and GFED (not recently updated) products.

Kevin Tansey invites experts to contribute to discussion around this topic and provide evidence that this work is being undertaken and progress against this action being made. Information on critical

improvements being made as a result of developments in products, uncertainty characterization, improvement in product accuracy, availability of archive data etc. is welcome.

Action T65:	Anthropogenic water use
Action	Collect, archive and disseminate information related to anthropogenic water use
Benefit	Accurate and up-to-date data on water availability and stress
Time frame	Continuous
Who	UN-Water, IWMI and FAO through AQUASTAT in collaboration with UN Statistics Division and other data sources
Performance indicator	Information contained in the AQUASTAT database.
Annual cost	US$ 100 000–1 million

Action T66:	Pilot projects: anthropogenic water use
Action	Develop and implement pilot data-collection exercises for water use
Benefit	Demonstrate data-collection approaches for wide implementation
Time frame	2016–2019
Who	GTN-H, UN-Water, IWMI and FAO through AQUASTAT in collaboration with the Convention on the Protection and Use of Transboundary Watercourses and International Lakes
Performance indicator	Completed data collection in pilot areas
Annual cost	US$ 100 000–1 million

Action T67:	Improve global estimates of anthropogenic greenhouse-gas emissions
Action	Continue to produce annual global estimates of emissions from fossil fuel, industry, agriculture and waste; improve these estimates by following IPCC methods using Tier 2 for significant sectors; this will require a global knowledge of fuel carbon contents and a consideration of the accuracy of the statistics used
Benefit	Improved tracking of global anthropogenic emissions
Time frame	Ongoing, with annual updates
Who	IEA, FAO, Global Carbon Project (GCP), Carbon Dioxide Information Analysis Centre (CDIAC), Emissions Database for Global Atmospheric Research (EDGAR)
Performance indicator	Availability of Improved estimates.
Annual cost	US$ 10 000–100 000

Action T68:	Use of satellites for Land use, land-use change and forestry emissions/removals
Action	Support the improvement of estimates of emissions and removals from Forestry and Land-use change by using satellite data to monitor changes where ground-based data are insufficient.
Benefit	Improved global and national monitoring of LULUCF
Time frame	Ongoing.
Who	National reporting supported by international agencies through programmes such as UNREDD and GFOI
Performance indicator	Availability of satellite data
Annual cost	US$ 100 000–1 million

Action T69:	Research on the land sink
Action	Research to better understand the land sink, its processes and magnitudes
Benefit	Better understanding of the global carbon cycle
Time frame	Ongoing
Who	GCP, research groups
Performance indicator	Published results
Annual cost	US$ 100 000–1 million

Action T70:	Use of Inverse modelling techniques to support emission inventories
Action	Develop inverse modelling methods to support and add credibility to emission inventories; develop and disseminate examples for several GHGs
Benefit	Added credibility of national emission/removal estimates and demonstration of inventory completeness
Time frame	Ongoing
Who	National Inventory agencies, researchers
Performance indicator	Published results
Annual cost	US$ 1–10 million

Action T71:	Prepare for a carbon-monitoring system
Action	Preparatory work to develop a carbon monitoring system to be operational by 2035; Development development of comprehensive monitoring systems of measurements of atmospheric concentrations and of emission fluxes from anthropogenic area and point sources to include space-based monitoring, in situ flask and flux tower measurements and the necessary transport and assimilation models
Benefit	Improved estimates of national emissions and removals
Time frame	Initial demonstration results by 2023 – complete systems unlikely before 2030
Who	Space agencies
Performance indicator	Published results
Annual cost	US$ 10–100 billion

Action T72:	Prepare for a latent and sensible heat flux ECV
Action	Review the feasibility of global monitoring of latent and sensible heat fluxes form the land surface; prepare proposals for such an ECV. Development of comprehensive monitoring systems of measurements of atmospheric concentrations and emission fluxes from anthropogenic point sources, to include space-based monitoring, in situ flask and flux tower measurements and the necessary transport and assimilation models
Benefit	Improve understanding of heat fluxes over land
Time frame	2017
Who	TOPC
Performance indicator	Proposals for consideration by GCOS Steering Committee
Annual cost	US$10 000–100 000