National Report on Global Climate Change Observing Systems in The Netherlands, September 2008

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Introduction

In The Netherlands several institutes contribute to the monitoring of Essential Climate Variables (ECVs). Funding can be long term (service based) as well as short term (project based). In principle, service based funded monitoring efforts are to be preferred in view of the demand for long term uninterrupted time-series. However, when carefully managed, project based monitoring can yield valuable contributions. Moreover, research elements can yield new or improved monitoring techniques that can be develop towards operational use.

In this report reference is made to the following institutes and consortia in The Netherlands that are involved in climate monitoring:

CESAR[1]; Cabauw Experimental Site for Atmospheric Research
Deltares; Dutch institute for Delta Technology
ECN; Energy research Centre of the Netherlands
NIOZ; NIOZ Royal Netherlands Institute for Sea Research
KNMI; Royal Netherlands Meteorological Institute
Rijkswaterstaat Waterdienst; Rijkswaterstaat Centre for Water Management
RIVM; National Institute for Public Health and the Environment
RUG-CIO; State university of Groningen, Center for Isotope research
TNO Built Environment and Geosciences/IGRAC; International Groundwater Resources Assessment Centre
UU-IMAU; Utrecht University, Institute for Marine and Atmospheric Research
WUR; Wageningen University and Research Centre - ALTERRA

Chapter 1: Common issues

1.1. Actions undertaken to introduce and/or enhance national coordination, as well as planning activities for the production and adoption of their own national implementation plans for observing, archiving and analysing their national contribution of observations of the ECVs:

Climate monitoring is a multidisciplinary activity, to which KNMI and partner institutes in the Netherlands contribute. On request by the Ministry of Housing, Spatial Planning and the Environment, KNMI leads a project that aims at national coordination and planning of climate monitoring activities, and the development of a national plan. This project will provide recommendations for a coordinated optimized contribution from The Netherlands to the Global Climate Observing System.

[1] A consortium that has set up and operates at the Cabauw site an observational reasearch facility with a comprehensive set of remote-sensing and in-situ equipment to characterise the state of the atmosphere, its radiative properties and intersction with the land surface for the study of physical and chemical processes, monitoring of the atmosphere and validation studies. Members are: Technical University Delft, KNMI, ECN, ESA-ESTEC, RIVM, TNO and WUR.

1.2. Efforts being undertaken to ensure that high-quality climate data records are collected, retained and made accessible for use by current and future generations of scientists and decision makers of all Parties:
(a) A significant part of the data is freely available. The policy is to make all data freely available by 2012.
(b) There are no policy-level barriers to the international exchange of climate data and their provision to international data centres.
(c) Most ECV-observing activities adhere to the GCOS climate monitoring principles (GCMPs). The less operational observations (e.g. for research) adhere to the GCMP's as much as feasible. Inhomogeneities resulting from changes in technology and observing practices are kept to a minimum. At KNMI a protocol is being developed to minimize discontinuities resulting from changes in measurement infrastructure, and to allow for the calculation of corrections in view of long-term climate records.
(d) At KNMI difficulties are sometimes encountered in protecting the integrity of long-term climate data records because of unforeseen changes in the availability of a site. A risk-analysis procedure is proposed to be part of the site selection to avoid this as much as possible.

1.3. Efforts undertaken to ensure that international data centres are established and/or strengthened for all the ECVs. Specifically (full names and numbers of relevant actions in the GCOS implementation plan are given in quotes and parentheses):

(a) Actions undertaken to "prepare the data sets and meta-data, including historical data records, for climate analyses and reanalyses" (C11):
KNMI will become a WMO Regional Climate Centre (RCC) for RA VI on daily climate data and climate indices, based on the ECA&D dataset.
(b) Actions undertaken to "establish sustainable systems for the routine and regular analysis of the ECVs including measures of uncertainty" (C12):
See 1.3.a.
(c) Steps taken to "establish a sustained capacity for global climate reanalysis and ensure coordination and collaboration between reanalysis centres" (C13):
No specific contribution.
(d) Experiences in diagnosing quality, availability and communications issues with climate data.
A National Oceanographic Data Commission performs the role of national oceanographic data centre. The data are distributed over data bases at different institutions, but will be accessible via a virtual data base at a single portal.

1.4. As for capacity-building, KNMI participates in the GCOS Cooperation Mechanism. The Netherlands announced a contribution of k€ 800 in total for 4 years (2007-2010) to the GCOS Action Plans for Africa at CoP12 in Nairobi, generated by two Ministries. In coordination with GCOS, projects are selected for support.
KNMI coordinates and supports (100 k€/y) the operation of a GAW station at the Meteorological Service of Surinam in Paramaribo. The radiation measurements are being upgraded to BSRN standards.

1.5. Initiatives undertaken to acquire palaeoclimate data, in particular activities to extend the data record in time and into new regions, and to improve the synthesis of these data:

KNMI carries out the processing of historical instrumental data (ship records and land based) and is involved in the "Buisman" reconstruction of 1000 year temperature in the Low Countries based on documented data.
Paleoclimate reconstructions are carried out at several universities.
Paleo-oceanographic research in the Netherlands is carried out by universities and institutions for fundamental research.

1.6. Providing information required in these guidelines is not hampered by specific difficulties.

1.7. Multinational and international projects and organizations conducting climate observations, including multinational satellite agencies:
Several Dutch organisations contribute to international programmes that produce ECV derived from satellite observations (KNMI, SRON, NIVR). In particular two nationally funded satellite instruments, SCIAMACHY and OMI, are exploited to generate records of atmospheric ECVs.
See also 1.3.a.

Chapter 2: Atmospheric Essential Climate Variables

2.1. Contributions to the monitoring of atmospheric ECVs are made by the following institutes:

CESAR (Cabauw Experimental Site for Atmospheric Research) is an observational facility with a comprehensive set of remote sensing and in-situ equipment to characterize the state of the atmosphere, its radiative properties and interaction with the land surface, for the study of physical and chemical processes, climate monitoring and validation studies. It is a co-operation between Delft University of Technology, KNMI, RIVM, ECN, TNO, ESA-ESTEC and WUR. A database is being operated, and new technologies are being developed for atmospheric observation to reduce gaps in climate knowledge, including space and ground based instruments, and improving representation of physical processes in climate models.

ECN (Energy Research Centre of the Netherlands) is monitoring atmospheric composition at the Cabauw tower since 1992 (continuous vertical gradients of CO2, CH4, N2O, SF6, H2 and 222Rn; continuous concentrations of halocarbons, event sampling for isotopic analysis in collaboration with RUG-CIO), and aerosols (size distribution, size resolved chemical composition, cloud forming properties, radiative properties). It is a partner in international projects such as CarboEurope IP, NitroEurope IP, and ICOS. Specific activities focus on network optimisation, capacity building in Eastern Europe, higher network density, data quality, emission verification for greenhouse gases and concentration data submission to bodies like EMEP and GAW.

KNMI (Royal Netherlands Meteorological Institute) is responsible for the operation of national networks for weather and climate monitoring, especially in the Atmospheric and Oceanic Domains. It is contributing to the global aircraft monitoring system AMDAR, as well as to the development and data provision of satellite instruments and retrieval techniques for atmospheric composition, aerosol and cloud monitoring and winds. KNMI leads the OMI instrument which continues the global ozone data record started with TOMS. KNMI is also contributing to observations at the Cabauw 200 m tower observatory, including a BSRN station. At a wider scope than the Atmospheric Domain, KNMI is responsible for collecting, quality controlling and identifying and filling gaps of observational time series and subsequent sustainable archiving in the National Observational Database. KNMI is digitizing and archiving national and a selected set of international historical observations. It is also co-organizer of a WMO workshop on data rescue for the Mediterranean area (RAVI and RAI). It contributes to national and international research to the reconstruction of instrumental and proxy series into high quality paleoclimate observational time series. Homogenisation of data sets and individual time series is done in cooperation with COST-ES0601. KNMI participates in the GCOS Cooperation Mechanism. The Netherlands announced a contribution of k€ 800 in total for 4 years (2007-2010) to the GCOS Action Plans for Africa at CoP12 in Nairobi, generated by the Ministries of V&W and VROM.

RIVM (National Institute for Public Health and the Environment) is operating the National Air Quality Monitoring Network, monitoring atmospheric composition (greenhouse gases, aerosols/particulate matter and other air quality parameters). On national level RIVM collaborates with partners in CESAR contributing with measurements of vertical profiles of water vapour, aerosols and clouds, and ground based measurements of aerosols/particulate matter (mass, size distribution and optical properties), UV radiation, and tropospheric ozone. RIVM is also contributing to international observation networks for ground based remote sensing of atmospheric composition, in particular EARLINET (European Aerosol Research Lidar Network) and NDACC (Network for Detection of Atmospheric Composition

Change) and GALION (GAW Aerosol Lidar Observation Network). In NDACC RIVM operates a stratospheric ozone lidar in Lauder, New Zealand.

RUG-CIO is operating a 60m tower observation point at Lutjewad (north-east coast) for greenhouse gas concentrations and fluxes of CO2. Besides continuous high precision concentration measurements of the gases CO2, CH4, CO, SF6 and N2O the concentrations of O2/N2 and 222Rn are measured. Also integrated samples of 14CO2 are taken. CIO-RUG also takes part in the CE-IP and ICOS project.

Table 1a. National contributions to the surface-based atmospheric essential climate

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Surface Network (GSN)	Air temperature	1	1	1	1	1
	Precipitation	1	1	1	1	1
Full World Weather Watch/Global Observing System (WWW/GOS) surface network	Air temperature, air pressure, wind speed and direction, water vapour	35 (land) 8 (sea)	35 8	35 8	35 8	35 8
	Precipitation	320	320	320	320	320
Baseline Surface Radiation Network (BSRN)	Surface radiation	1	1	1	1	1
Solar radiation and radiation balance data	Surface radiation	34	34	34	34	34
Ocean drifting buoys	Air temperature, air pressure	KNMI participates in	DBCP and E-Surfmar			
Moored buoys	Air temperature, air pressure					
Voluntary Observing Ship Climate Project (VOSClim)	Air temperature, air pressure, wind speed and direction, water vapour	40	40	80	40	40
Ocean Reference Mooring Network and sites on small isolated islands	Air temperature, wind speed and direction, air pressure					
	Precipitation					

Table 1b. National contributions to the upper-air atmospheric essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Upper Air Network (GUAN)	Upper-airtemperature, upper-air wind speed and direction, upper-air water vapour					
Full WWW/GOS Upper Air Network	Upper-airtemperature, upper-air wind speed and direction, upper-air water vapour	1	1	1	1	1

Remark: Cloud and aerosol properties are among the ECVs in the Atmospheric Domain, but are not listed in table 1b. See Chapter 5 for activities in The Netherlands on cloud monitoring.

Table 1c. National contributions to the atmospheric composition

Contributing networks specified in the GCOS implemen-tation plan	ECVs	Number of Stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological Organization/ Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO2 & CH4 Monitoring Network	Carbon dioxide	3	3 As much as possible	6	3	1
	Methane	3	3 As much as possible	6	3	1
	Other greenhouse gases	3 (O3)	3 As much as possible	6	3	1
WMO/GAW ozone sonde network	Ozone	2	2	2	2	2
WMO/GAW column ozone network	Ozone	2	2	2	2	2
WMO/GAW Aerosol Network	Aerosol optical depth					
	Other aerosol properties					

2.2. Satellite measurements for the atmospheric ECVs and associated global products in which KNMI is involved are listed in Table 2.

Table 2. Global products requiring satellite observations and measurement techniques used
The Netherlands, and especially KNMI, is involved in measurements listed below.

ECVs/ Global products requiring satellite observations	**Fundamental climate data records required for product generation (from past, current and future missions)**
Surface wind speed and direction Surface vector winds analyses, particularly from reanalysis	Scatterometry
Water vapour Total column water vapour over land	GPS
Cloud properties Cloud radiative properties (initially key ISCCP products)	VIS/IR imagery
Precipitation Improved estimates of precipitation, both as derived from specific satellite instruments and as provided by composite products	Passive microwave radiances, active radar (for calibration)
Ozone Profiles and total column of ozone	UV/VIS and IR microwave radiances
Aerosol properties Aerosol optical depth and other aerosol properties	VIS/NIR/SWIR radiances

2.3. Actions taken in response to the following recommended actions on the atmospheric ECVs contained in the GCOS implementation plan (numbers of relevant actions in the plan are given in parentheses):

(a) Applying the GCMPs to all surface climate networks (A3):
All ECV-observing activities adhere to the GCOS climate monitoring principles (GCMPs). Inhomogeneities resulting from changes in technology and observing practices are kept to a minimum. A protocol is being developed to minimize discontinuities resulting from changes in measurement infrastructure, and to allow for the calculation of corrections in view of long-term climate records.
(b) Incorporating atmospheric pressure sensors into drifting buoy programmes (A5):
KNMI participates in DBCP and E-Surfmar.
(c) Ensuring availability of three-hourly mean sea level pressure and wind speed and direction data from GSN stations (A10):
These data are available.
(d) Implementing a reference network of high-altitude, high-quality radiosondes (A16):
The Netherlands is not involved in the development of a Reference Network.
KNMI and CESAR are active in a related field: the Cabauw site is part of GRUAN.
(e) Operating the WWW/GOS radiosonde network in full compliance with the GCMPs and coding conventions (A17):
KNMI operates a regular radiosonde station (2 flights per day) at De Bilt (06260), in full compliance with the GCMPs and coding conventions;
(f) Submitting metadata records and inter-comparisons for radiosonde observations to the specified international data centres (A18):
Meta-data records are submitted. There are no specific intercomparisosns in The Netherlands.
(g) Developing a network of ground-based Global Positional System (GPS) receivers for measuring water vapour (A21):
A network of 35 stations is in operation since 2005. The data are archived and available.
(h) Sustained measurements of the atmospheric composition ECVs, supplementary to those activities implicit in table 1c:
ECN is monitoring atmospheric composition at the Cabauw tower since 1992 (continuous vertical gradients of CO2, CH4, N2O, SF6, Halocarbons, Rn and H2, event sampling for isotopic analysis in collaboration with RUG-CIO), and aerosols (size distribution, size resolved chemical composition, cloud forming properties, radiative properties).

Chapter 3: Oceanic Essential Climate Variables

3.1. Contributions to the monitoring of oceanic ECVs are made by the following institutes:

Deltares works for and cooperates with Dutch government, provinces and water boards, international governments, knowledge institutes and market parties in the field of water, soil and the subsurface of vulnerable deltas, coastal areas and river basins.
As a new and independent institute they are responsible for development of operational hydrodynamical and water quality models. Of relevance is the analysis and integration of different information sources into quality status reporting of the North Sea. Together with parts of Rijkswaterstaat Deltares advices the area of Water policy from coastal flooding to EU-Directives on Marine water quality.

KNMI (Royal Netherlands Meteorological Institute) is responsible for the operation of national networks for weather and climate monitoring, especially in the Atmospheric and Oceanic Domains. As for the Oceanic Domain KNMI contributes to the international VOS, VOSClim and ARGO networks. KNMI also contributes to the quality control of the US Maury Colllection.

NIOZ (Royal Netherlands Institute for Sea Research) is an institute for fundamental multidisciplinary research in coastal seas and oceans. In the framework of that research a number of climatic monitoring programmes are maintained. In the western Wadden Sea the benthic ecosystem is monitored since over 30 years, while continuous observations of sea surface temperature and salinity extend a time series, started in 1860. Moored profiling CTDs in the Irminger Sea monitor the hydrography of the Irminger Sea since 2003. A moored current meter array in the Mozambique Channel determines the ocean transport at the tropical-subtropical connection in the western Indian Ocean. NIOZ intends to submit its vast archive of sea surface temperature and salinity data to the appropriate GCOS data centre.

Rijkswaterstaat Centre for Water Management is operating the North Sea Monitoring Network covering the Dutch Continental Shelf (wave buoys, fixed sea level monitoring stations, water temperature). It also runs a chemical monitoring programme (22 offshore ship based fixed stations (32x/year temperature, salinity, nutrients, micro pollutants etc.) and combined biological monitoring programme (phytoplankton, zoo-plankton, (shell-) fish, birds etc.). Rijkswaterstaat Centre for Water Management also carries out a coastal research programme (local and large scale coastal dynamics related to sea level rise).

Under the National Offshore Mining Act oil and gas exploration production platforms monitor and distribute data on waves, sea level, temperature, wind etc. A yearly morphological survey and coastline monitoring (dune height and bathymetry up-to 20 m) is carried out as well. Other activities are SEPRISE (Sustained, Efficient Production of Required information Services) for real time oceanographic data, Pan-European infrastructure for Ocean & Marine Data Management (SEADATANET) for historical data and North West Shelf Operational Oceanographic System (NOOS) for North Sea monitoring and modelling capacity.
Rijkswaterstaat Directorate North Sea is maintaining a Ferrybox –line (NL-Norway) with VOS weekly service for waterquality parameters. A comparable suite of sensors is installed on a fix buoy near Oysterground.

3.2. Actions in nominating national focal points for implementation of the oceanic observing system for climate and establishing partnerships between the ocean research and operational communities:

KNMI is national focal point for ARGO and for the Data Buoy Cooperation Panel.

Table 3a. National contributions to the oceanic essential climate variables – surface

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global surface drifting buoy array on 5x5 degree resolution	Sea surface temperature, sea level pressure, position-change based current					
GLOSS Core Sea-level Network	Sea level				4	2
Voluntary observing ships (VOS)	All feasible surface ECVs	200	200	200	200	200
Ships of Opportunity	All feasible surface ECVs	2		4	1	0

Table 3b. National contributions to the oceanic essential climate variables – water column

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global reference mooring network	All feasible surface and subsurface ECVs					
Global tropical moored buoy network	All feasible surface and subsurface ECVs					
Argo network	Temperature, salinity, current	14	14	20	14	20
Carbon inventory survey lines	Temperature, salinity, ocean tracers, biogeochemistry variables					

3.3. Actions taken in response to the following recommended actions on the oceanic ECVs contained in the GCOS implementation plan (numbers of relevant actions in the plan are given in parentheses):

(a) Improving metadata acquisition and data management for the VOSClim subset of the VOS (O6):
At KNMI data entry software (TurboWin) for VOS and VOSClim is developed and maintained. The software is kept up-to-date with the latest data and meta-data requirements according to JCOMM's SOT and ETMC advices. TurboWin complies completely with the latest VOSClim requirements.
(b) Ensuring that high-frequency (hourly or less) sea level observations are available for all coastal tide gauges, including historical records, are corrected for sea level pressure and are submitted to the specified international data centres (O13):
Rijkswaterstaat is sharing Sealevel data of 5 coastal stations in the Dutch Coastal waters through EuroGOOS-NOOS. Historical SL-data is available through SeaDataNet on Pan-European scale.

(c) Including sea level objectives in the capacity-building programmes of GOOS, JCOMM, WMO, other related bodies and the system-improvement programme of GCOS (O14):
No contribution.
(d) Developing a robust programme to observe sea surface salinity, to include VOS ships, research ships, reference moorings and drifting buoys (O15):
Rijkswaterstaat is maintaining an automatic monitoring programme (Ferrybox) on a freight Coaster-line IJmuiden-Bergen (N) and runs a undulating fish and Ferrybox monitoring programme on their survey vessel (Zirfea) during weekly cruises (T, S, DO, Nutrients, light, TSM, phytoplankton).
(e) Implementing a programme for measuring surface pCO2 (O17):
No contribution.
(f) Implementing a wave measurement component as part of the Surface Reference Mooring Network (O19):
No contribution.
(g) Improving in situ sea ice observations from buoys, visual surveys (Ship of Opportunity Programme (SOOP) and aircraft) and upward-looking sonar's, and implementing observations in the Arctic and Antarctic (O23):
No contribution.
(h) Conducting the systematic global full-depth water column sampling of 30 sections repeated every 10 years (including ocean carbon inventory change) (O25):
Since 2000 NIOZ performs a bi-annual hydrographic survey of the WOCE AR7E section between Ireland and Greenland, including temperature, salinity, dissolved oxygen, nutrients, and total dissolved carbon.
(i) Performing the 41 SOOP XBT/XCTD trans-oceanic sections (O26):
No contribution.
(j) Developing capability for systematic measurement of biogeochemical and ecological ECVs (O30):
No contribution.
(k) Supporting data rescue projects and implementing regional, specialized and global data and analysis centres (O36 and O37):
At KNMI the HISKLIM project overarches different smaller projects in which data rescue is the main issue. Data from mainly Dutch, land based stations are keyed or scanned and made available to a larger audience. Special software is developed at KNMI to extract data from graphs (pluviographs, barographs, wind registrations, thermographs, etc.). In collaboration with NCDC (Asheville, NC, USA), several Dutch ship logbooks (1854-1880) will be keyed.

Chapter 4: Terrestrial Essential Climate Variables

4.1. Contributions to the monitoring of terrestrial ECVs are made by the following institutes:

Rijkswaterstaat Centre for Water Management monitors the physical, chemical and biological state of the main water system in the Netherlands. This includes waterlevels and discharge at the main inflow (e.g. river Rhine and Meuse) and the discharge to the Sea.Water levels, temperature and some other physical parameters are measured on a continuous basis.
Rijkswaterstaats monitors and archives water related data as part of its legal task (MWTL - Monitoring Programme of the National Water Systems). This includes ECVs, the discharge of River Meuse and Rhine.

The TNO Built Environment and Geosciences is monitoring groundwater levels and groundwater quality. Measurement series of groundwater levels and groundwater quality at approximately 20.000 sites in the Netherlands are stored in the DINO-system. The DINO-system is the central storage site for geo-scientific data on the shallow and deep Dutch subsurface and resorts under the DINO-programme, aimed at maintaining and improving the National Geological Database in the Netherlands. There is an on-going research programme to improve data acquisition, data storage and data distribution. The focus is on sensor networks and Sensor Web Enablement (SWE). Some initial research has been conducted investigating the relation between climate change and groundwater.

IGRAC (International Groundwater Resources Assessment Centre) has taken initiative to establish a Global Groundwater Monitoring Network (GGMN). The network will become operational in 2008, having a web-based application and people network as the main components. This network will provide crucial data for the climate change - groundwater analyses. It will use aggregated information from existing networks in order to represent a regional change of groundwater resources at the scale relevant for the global assessment. The main challenge is setting up a people network (read further at http://www.igrac.nl/publications/281.) With the GGMN, IGRAC is responsible for the global groundwater observations in the GEO (Group of Earth Observations) work plan for 2009-2011 and in the GCOS/WMO Global Terrestrial Network Hydrology (GTH-N). Besides, IGRAC is involved in several projects and initiatives related to impact of climate change on groundwater such as Initiative with Cooperative Programme on Water and Climate (CPWC) and Groundwater Resources Assessment under the Pressures of Humanity and Climate Changes (GRAPHIC).

UU-IMAU (Utrecht University, Institute for Marine and Atmospheric Research) is monitoring ice-caps and glaciers. Automatic weather stations are operated on glaciers in the Alps, Norway, Greenland and Antarctica. Mass balance measurements are carried out on the Greenland ice sheet.

WUR (Wageningen University and Research Centre) is monitoring soil and soil moisture parameters, land-use (change) and land bound GHG emissions. Fluxes of CO2, water vapour, sensible heat and momentum are continuously monitored at Loobos forest site since 1994. Additional flux monitoring sites (also including N_2O and CH_4 fluxes) are being operated for shorter periods over a variety of other land cover types (crops, grasslands, peatlands, etc). This flux monitoring network is a collaborative action between WUR and a number of other universities and research centres (VU Amsterdam, ECN, TNO, RUG and KNMI), largely initiated through the CarboEurope and NitroEurope projects. Data are managed and made accessible at national and European level. It also provides observations and archiving of phenological data (Nature's Calendar).

The Netherlands Environmental Assessment Agency (MNP) coordinates Emission Database for Global Atmospheric Research (EDGAR) information system. This is a joint project of research institutes in the Netherlands, Italy and Germany. It stores global emission inventories of direct and indirect greenhouse gases from anthropogenic sources including halocarbons and aerosols both on a per country and region basis as well as on a grid. The Netherlands Environmental Assessment Agency (MNP) also coordinates the History Database of the Global Environment (HYDE). It presents not only (gridded) time series for the last 300 years of population and land use, but also various other indicators such as GDP, Value Added, Livestock, Private Consumption, GHG emissions, and Industrial production data.

4.2. Efforts to introduce national coordination and planning of terrestrial programme activities:

A terrestrial GHG monitoring facility is currently being organised as Dutch contribution to the European ESFRI programme ICOS (Integrated Carbon Observing System, http://icos-infrastructure.ipsl.jussieu.fr/). Building on partnerships developed during the European 'CarboEurope-IP' and the national 'Climate Changes Spatial Planning' programme a 20M€ proposal has recently been submitted to establish a monitoring and modelling infrastructure for GHG exchange and atmospheric composition covering a period of 5 year but explicitly intended to run for many years after that. It foresees the establishment /continued operation of a number of tall-towers for high precision, multiple GHG concentration monitoring, and a C14 lab, a number of fluxtowers covering the main landscape elements, aircraft operations, and inverse modelling facilities.

Table 5. National contributions to the terrestrial domain essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS baseline river discharge network (GTN-R)	River Discharge	1	1	1	1	1
GCOS Baseline Lake Level/ Area/Temperature Network (GTN-L)	Lake level/area/ temperature					
WWW/GOS synoptic network	Snow cover Only on precipitation stations, not GOS	320 See 4.3.d	320 See 4.3.d	320 See 4.3.d	320 See 4.3.d	320 See 4.3.d
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass balance	See 4.3.e	See 4.3.e	See 4.3.e	See 4.3.e	See 4.3.e
GCOS permafrost monitoring network (GTN-P)	Permafrost Borehole temperatures and active-layer thickness					

4.3. Actions taken in response to the following recommendations on the terrestrial ECVs contained in the GCOS implementation plan (numbers of relevant actions in the plan are given in parentheses):

(a) Developing a global network of approximately 30 sites based on a progressive evolution of existing reference sites to monitor key biomes and provide the observations required for the calibration and validation of satellite data (T3):
(One of the) Sites covered by the ICOS infrastructure (see 4.2) could be part of this network, being very suited because of a long term monitoring history. International coordination to become part of this reference site network needs still to be initiated.
(b) Maintaining and expanding programmes for monitoring groundwater and aquifers (GCOS-IP Milestone):
IGRAC has taken an initiative to develop a Global Groundwater Monitoring System. This system will provide data for analyses of climatic change impact on groundwater resources.
Special attention will be paid to recharge and salinisation in coastal aquifers. In October 2007 IGWCO/GARS/UNESCO groundwater working group has organized a high-profile international workshop at IGRAC to define the postulates of GGMS.
The data to be collected for GGMS at the territory of the Netherlands are readily available at TNO Built Environment and Geosciences.
(c) Archiving and disseminating information related to irrigation and water resources (T9):
See (b).

(d) Strengthening existing sites for observing snow cover and snowfall and recovering and submitting historical data to the specified international data centres (T10):
KNMI measures snowfall, snowcover and snowheight on manned precipitation stations, on GOS stations only snowfall.
(e) Maintaining sites for observing glaciers and adding additional sites and infrastructure in Africa, the Himalayas, New Zealand and South America (T13):
UU-IMAU (Utrecht University, Institute for Marine and Atmospheric Research) is monitoring ice-caps and glaciers on a research basis at various locations, e.g. by collecting photographic documentation. Automatic weather stations are operated on glaciers in the Alps, Norway, Greenland and Antarctica. Mass balance measurements are carried out on the Greenland ice sheet.
(f) Adding the 150 additional permafrost sites identified by GTN-P to cover the high mountains of Asia, Europe and the southern hemisphere, and the North American alpine lands and lowlands, and providing data to the specified international data centres (T16):
No contribution.
(g) Reanalysing historical data concerning the terrestrial ECVs (no reference in GCOS-IP):
To the author's awareness, currently no re-analysis effort with terrestrial ECVs is undertaken.

Chapter 5: Additional information

Additional information on national climate programmes that contribute observations of the ECVs not reported elsewhere in this report:

(a) KNMI contributes to the WMO IOC DBCP activities.
(b) KNMI participates in the EUMETNET SURFMAR programme.
(c) At KNMI ocean stress is derived from satellite observations.
(d) The CESAR consortium (7 Netherlands' Institutes) operates various ground based remote sensing systems at the Cabauw site that measure cloud and aerosol properties in view of monitoring and research. Also improved measurement techniques are being developed.
(e) IGRAC is responsible for the global groundwater observations in the GEO (Group of Earth Observations) work plan for 2009-2011 and in the GCOS/WMO Global Terrestrial Network Hydrology (GTH-N). This network is not mentioned in Table 5. See also 4.1.
(f) The Netherlands is at the forefront of the development of the Integrated Carbon Observation System (ICOS), both nationally and internationally.
(g) Deltares is responsible in EuroGOOS-NOOS as chair on the issue of coordinating monitoring activities on the NOOS-targeted area (NE Continental Shelf). The focus is on the water quality (chemical/biological) related variables related to Quality Status Reporting and trend analysis related to impacts from EU-Marine Strategy Policy measures. Impact of climate change in coastal sea should be extracted from trends by Global correlations.