COORDINATED ASIA-EUROPEAN LONG-TERM OBSERVING SYSTEM OF QINGHAI – TIBET PLATEAU HYDRO-METEOROLOGICAL PROCESSES AND THE ASIAN-MONSOON SYSTEM WITH GROUND SATELLITE IMAGE DATA AND NUMERICAL SIMULATIONS

CEOP-AEGIS

Thematic Priority: ENV.2007.4.1.4.2.

Improving observing systems for water resource management

4th Reporting Period Summary

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CONTRACTORS INVOLVED

1	ICube Laboratory (UMR 7357 University of Strasbourg, CNRS)	France
2	University of Twente	The Netherlands
3	ARIES Space	Italy
4	University of Bayreuth	Germany
5	Alterra - Wageningen University and Research Centre	The Netherlands
6	University of Valencia	Spain
7	Institute for Tibetan Plateau Research	China
8	China Meteorological Administration	China
9	Beijing Normal University	China
11	University of Tsukuba	Japan
12	WaterWatch	The Netherlands
13	Cold and Arid Regions Environmental and Enginering Research Institute	China
14	University of Ferrara	Italy
15	Institute of Geographical Sciences and Natural Resources Research	China
16	Institute for Remote Sensing Applications	China
17	Future Water	The Netherlands
18	Delft University of Technology	The Netherlands
19	National Institute of Technology	India

Start Date of the Project: 1st May 2008

Duration: 60 months

CONTEXT

Human life and the entire ecosystem of South East Asia depend upon the monsoon climate and its predictability. More than 40% of the earth's population lives in this region. Droughts and floods associated with the variability of rainfall frequently cause serious damage to ecosystems in these regions and, more importantly, injury and loss of human life.

The headwater areas of seven major rivers in SE Asia, i.e. Yellow River, Yangtze, Mekong, Salween, Irrawaddy, Brahmaputra and Ganges, are located in the Tibetan Plateau. Estimates of the Plateau water balance rely on sparse and scarce observations that cannot provide the required accuracy, spatial density and temporal frequency. Fully integrated use of satellite and ground observations is necessary to support water resources management in SE Asia and to clarify the roles of the interactions between the land surface and the atmosphere over the Tibetan Plateau in the Asian monsoon system.

A series of international efforts initiated in 1996 with the GAME-Tibet project. The effort described in this proposal builds upon 10 years of experimental and modeling research and the consortium includes many key-players and pioneers of this long term research initiative. The processes summarized above lead to identify the elements of a comprehensive system useful to observe timely the state of land surface over the Plateau, extract precursor information to improve forecast precipitation over the headwater areas of the Yellow River, Yangtze, Mekong, Salween, Irrawaddy, Brahmaputra and Ganga, monitor the water balance of the Plateau and its water yield, and assess the consequences of such forecasts in terms of floods and droughts, as well as contribute to establish an infrastructure for the Group on Earth Observations (GEO) water theme and capacity building in S and E Asia.

OBJECTIVES

THE GOAL OF THIS PROJECT IS TO:

1. Construct out of existing ground measurements and current / future satellites an observing system to determine and monitor the water yield of the Plateau, i.e. how much water is finally going into the seven major rivers of SE Asia; this requires estimating snowfall, rainfall, evapotranspiration and changes in soil moisture;
2. Monitor the evolution of snow, vegetation cover, surface wetness and surface fluxes and analyze the linkage with convective activity, (extreme) precipitation events and the Asian Monsoon; this aims at using monitoring of snow, vegetation and surface fluxes as a precursor of intense precipitation towards improving forecasts of (extreme) precipitations in SE Asia.

THE SPECIFIC OBJECTIVES ARE:

TO IMPROVE SPATIAL DENSITY AND TEMPORAL FREQUENCY OF OBSERVATIONS WITH:

1. Ground based observations of radiative and turbulent fluxes and soil moisture over the Plateau at a limited but representative set of permanent sites; data quality and footprint analysis for upscaling on satellite grid elements;

2. Satellite observations of snow and vegetation cover, of surface albedo and temperature over the Plateau;
3. Satellite based estimates of energy and water fluxes over the Plateau;
4. Satellite based estimates of top soil moisture over the Plateau;
5. Integrated ground and satellite observations of precipitation over the Plateau;
6. Estimation of glaciers and snow meltwater using ground and satellite observations;

CONTRIBUTE TO ADVANCE UNDERSTANDING OF LAND-ATMOSPHERE INTERACTIONS, MONSOON SYSTEM AND PRECIPITATION:

7. Numerical Weather and Climate Prediction modelling system to link these observations with precipitation forecasts over the Plateau and surrounding areas;

ESTABLISH A PROTOTYPE OBSERVING SYSTEM FOR LARGE AREA WATER MANAGEMENT BY:

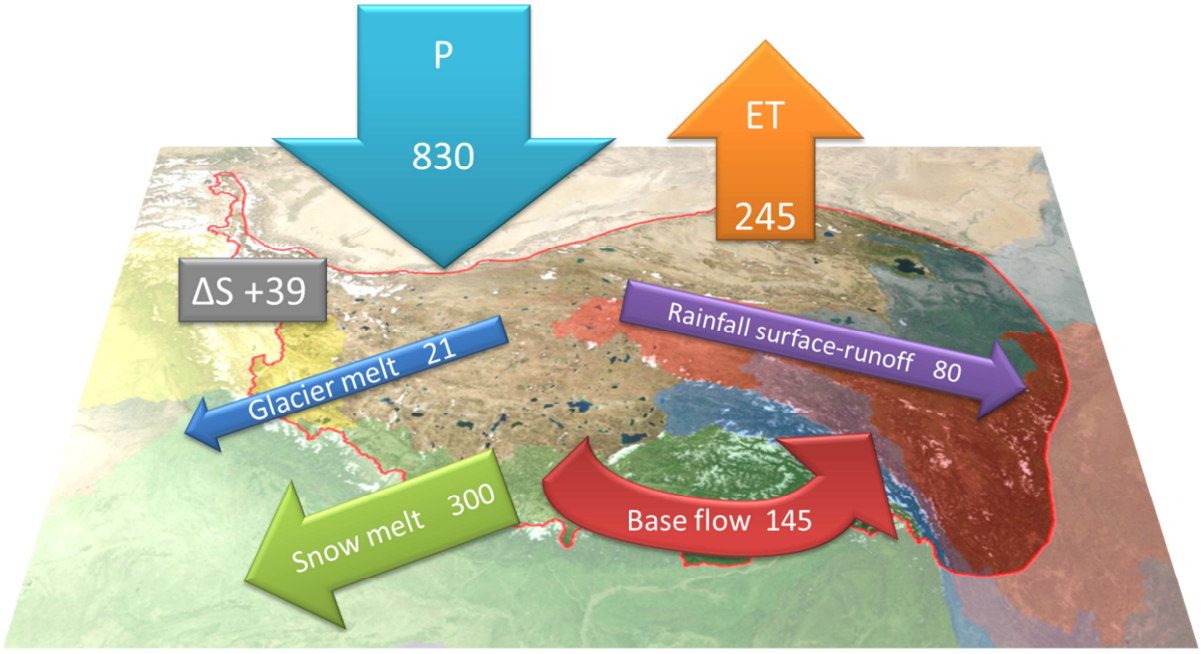
8. Monitoring the water balance and water yield of the Plateau

DEMONSTRATE THE BENEFITS OF THE OBSERVING SYSTEM WITH PILOT PROJECTS ON:

9. Satellite based drought monitoring system of pilot areas of China and India;
10. Satellite based flood monitoring system of pilot areas of China and India;

CONTRIBUTE TO A GEO WATER THEME AND CAPACITY BUILDING INFRASTRUCTURE FOR SE ASIA

11. Dissemination and Stakeholders Panel



Water balance components Tibetan Plateau (area within red boundary) 2008-2010 (mm/yr).

WORK PERFORMED

The 4th Annual Progress Meeting was held in Delft at the Faculty of Civil Engineering and Geosciences of the Delft University of Technology on June 13th and 14th 2012. The 5th and Final Progress meeting was held on April 25th 2013 at the Remote Sensing and Digital Earth Institute (RADI) – Chinese Academy of Sciences in Beijing. The meeting was attended by 30 participants. In preparation of the meeting all partners were requested to prepare an overview presentation for each Work Package. The project was concluded with an International Workshop attended by 150 Participants from 13 Countries

Work under WP 1 through 6 was focused on improving and completing the data sets which had been provided and uploaded in the previous reporting period. The first experiments with the Plateau water balance model identified some inconsistencies in the snow water equivalent and precipitation data sets, which were re-processed. Work under WP7 addressed methods to detect and monitor convective events using a combination of satellite observations and numerical experiments. The impact of land surface conditions on meso-scale atmospheric circulation was analysed by numerical experiments based on hypotheses on surface fluxes and surface wetness. All data sets were used to model the water balance of the Plateau was completed (WP8). Time series analysis of satellite data for drought (WP9) and flood (WP10) early warning was focused on the evaluation of new indicators to improve the detection of anomalies. The 2nd Training Session was held at NIT Rourkela. A full list of publications is available on the project web-site.

MAIN RESULTS

IMPROVEMENT OF RETRIEVAL ALGORITHMS, PROCESS MODELS AND LAND-ATMOSPHERIC MODELS

The development of algorithms, process and large area models has been completed. New or significantly improved algorithms have been developed and evaluated against ground measurements. Variables retrieved include land surface properties, rain rate, aerosol optical depth, water vapour, snow cover and water equivalent, soil moisture and lake level. Common to all algorithms developed is the capability to make use of heterogeneous raw data. A new system has been implemented to monitor actual evaporation to be evaluated against new heat flux data products derived from eddy-covariance and scintillometer raw data. The three years time series of gap-free daily and hourly evaporation derived from geostationary data collected by the FY-2D satellite is a major achievement of the project.

PRODUCTION OF DATA SETS

An improved and final version of all expected data products has been generated and made available on the project data portal.

CASE-STUDIES WITH HYDROLOGIC AND ATMOSPHERIC MODELS

The hydrologic modeling system has been implemented and applied for the entire study area, i.e. the Qinghai Tibet Plateau and the headwaters of the major rivers in Southern and Easterrn Asia. A case study for the Upper Yellow River Basin has been carried out. Evaluation against river flow data is ongoing in Chin and India. Case studies on response of atmospheric circulation and specifically of convective activity to land surface conditions

have been completed and the controlling land surface conditions and processes have been documented.

Case-studies on drought monitoring and early warning

A tool-kit has been developed and applied to monitor recent and severe drought events for the evaluation of the system. Two new drought indicators were proposed which are Normalized Temperature Anomaly Index (NTAI) and Normalized Vegetation Anomaly Index (NVAI). Case study in China and India showed that these two drought indicators were able to capture the drought evolution at different stage of drought occurrence. i.e. the NTAI responds earlier than the NVAI.

Modeling and visualization of flood events and inundation

Several case studies have been completed in China and India making use of very diverse satellite data.

Stakeholders and capacity building

The 3rd stakeholders and training event saw 20 participants from both partner and external organizations. There are 93 PhD and 79 MSc students completing their education in the framework of the project. The project was concluded with an International Workshop attended by 150 Participants from 13 Countries

Final Results

- A database containing ground observations, satellite data and higher level products, hydrologic and atmospheric model fields for the period 2008 – 2010 over the Qinghai – Tibet Plateau.
- A system to generate daily streamflow in the upper catchment of all major river in SE Asia gridded to 5 km x 5 km.

Potential Impact and Use of Results

Implementation and demonstration of an observing system of water balance and water flow on and around the Qinghai – Tibet Plateau will provide to all countries information on water resources and the role of the Plateau in determining weather and climate in the region. The data portal developed and popoluated by the project is resident at the Institute of Tibetan Plateau Research of the Chinese Academy of Sciences, the leading chinese organization of the Third Pole Environment Program, which is very likely to grow and last for next several years. We are also expecting to involve ICIMOD in Kathmandu in follow up activities. The commitment of both ITP and ICIMOD should improve the long term fruition of tools and data products developed by the project.

Project objectives and achievements for the last period

During the 5th and last year of the project we concentrated on using the data sets generated so far to model the water balance and water conveyance of the entire Qinghai – Tibet Plateau of the headwaters of major rivers streaming down the Plateau to neighbouring Countries in South and East Asia. The satellite data sets and additional extended time series were used to identify most significant anomalies in surface conditions and likely to have a significant impact on mesoscale atmospheric circulation. These linkages have been evaluated using such detected anomalies instead of hypothetical patterns in land surface conditions, as done so far. The

same time series of satellite data will be used to demonstrate timely detection and prediction of drought and flood events towards drought and flood early warning. The project was concluded with two stakeholders event: the 3rd and last Training Session was held at RADI and the open international workshop WATGLOBS at the Olympic Village campus of the Chinese Academy of Sciences in Beijing.