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Division of Early Warning and Assessment - Global Resource Information Database

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Central Asia Glaciers' Study - Current state of knowledge and recommendations

By Bruno Chatenoux

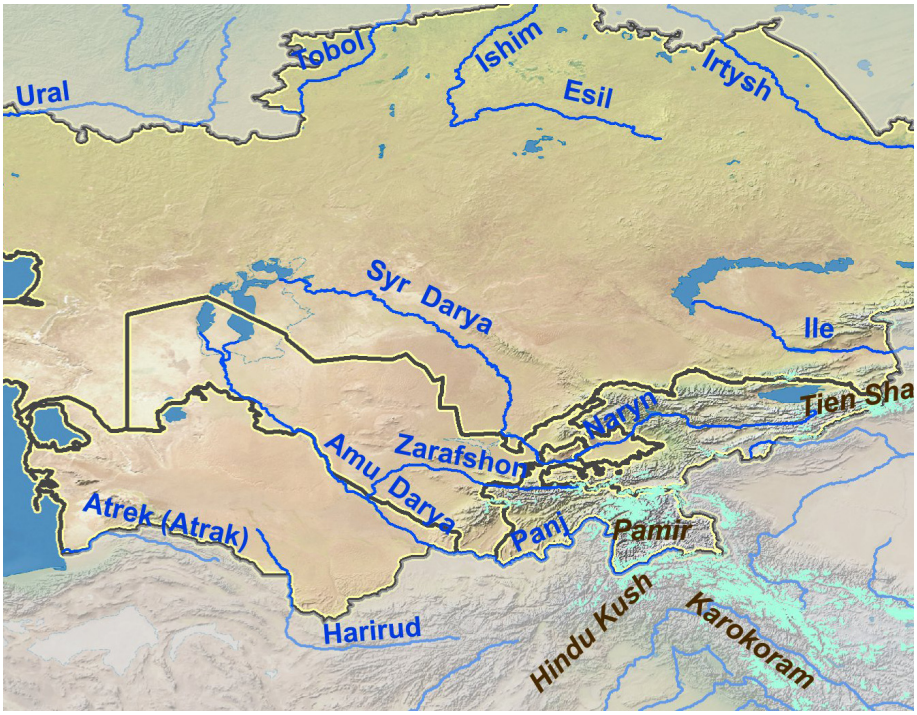
In the five Central Asian countries (Kazakhstan, Kyrgyzstan, Turkmenistan, Tajikistan and Uzbekistan), 40% of the population depends on glacier melt as their main water resource. Irrigated agriculture consumes around 90% of the annually available surface water resources and constitutes an important contributor to gross domestic product, employment, food security and energy production. Ice bodies are highly sensitive to climate change. Central Asia will probably be subject to cross-sectoral stresses (energy, industry, basic needs, environment, etc.) in the near future that could subsequently jeopardize many hard-won development gains. Thus, there is an urgent need for synthesising the available information and identifying knowledge and data gaps.

DEWA/GRID-Europe was mandated by UNDP to synthesise information on glacial melting in Central Asia, to identify the gaps in knowledge and data and to provide recommendations on how to address those gaps. Across Central Asia, all data analyses indicate a more than average increase in temperatures (from 0.08 to 0.29°C/decade), mainly reflected in higher winter temperatures. The regional trend shows an average shrinking of 0.6 - 0.8% of the glaciers' area per year and about 1% per year in volume. The smallest glaciers show the quickest decreases. However, analysis of precipitation trends, snow cover and river discharges at the regional level did not reveal any specific trend.

Discussions and controversies on actual values, trends and causes of glacial melt are due to local effects and behaviour that cannot be regionalized, but also to an extreme fragmentation of baseline data and scientific research (past and ongoing), as well as obvious data gaps following the end of the ex-Soviet Union (USSR) at the beginning of the 1990s. This adds to the complexity of trying to reach a regional understanding of glaciers' status and trends, and of any plan for water resources management.

Under the current climate change scenarios from the Intergovernmental Panel on Climate Change (IPCC), the ongoing trend of global and rapid, if not accelerating, glacier shrinkage on the century time scale is of non-periodic nature and may lead to the deglaciation of large parts of many mountain ranges in the coming decades. Moreover, the model-predicted changes have already been seen in the observed data. If maintained at the current levels, they will lead to serious changes in the water availability in many regions of the Earth within the next few decades, and particularly in Central Asia because of its high reliability on glaciers and its natural sensibility to climate change.

Hence, strong and clear actions need to be defined and implemented as soon as possible in order to get a clearer image of glacier status and potential evolution, and the related impacts on water supply in Central Asia. This should then be translated into the adoption of appropriate decisions for adaptation to climate change in the region. Along with a multi-country integrated water resources management initiative, the scientific assessment of glacier status should be prioritized, and studies on the identification of potential impacts in



Main rivers and glaciers of Centra Asia (source: Natural Earth and GLIMS)

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the region should be carried out through:

- Establishment of a common baseline data set for glacier monitoring, climate and hydrology in Central Asia
- Acquisition of new data through the re-activation of monitoring networks interrupted in the 1990s, to give a longer-term view (in a climate change study objective, meaning 10-20 years periods of time), and a strong prioritization of locations and parameters.
- Creation of a new catalogue of glaciers, on the basis of remote sensing with appropriate field calibrations.
- Establishment (in a legal and technical sense) of a network that will allow any project to freely and easily access data.
- Coordination between ongoing international bodies - such as the Global Terrestrial Network for Glaciers (GTN-G), the World Meteorological Organisation (WMO), the Global Runoff Data Centre (GRDC) - and regional projects - such as the Central Asian Water (CAWa), the future Central Asian Regional Glaciological Centre and the Global Environment Facility (GEF).

Due to the lack of information on rock glaciers and permafrost, more specific studies should be done on these, as they are important sources of water and they react differently than ice glaciers to environmental changes.

Geo-hazards - such as glacial lake outburst floods and landslides - constitute short-to-medium-term threats, and activities should be reinforced by national authorities in terms of monitoring (as part of general monitoring activities), including early warning and civil engineering solutions if needed.

Two important points should be mentioned. First, in order to guarantee the sustainability of work of this project, it is crucial to increase capacities within relevant regional services, as well as building capacity in human resources. Second, there is a strong need to raise awareness at the community level. This will serve multiple essential purposes: it will guarantee proper monitoring of the glaciers, increase the protection of on-the-ground equipment, and may also improve the potential for early warning of glacier changes.

First meeting of the TWAP's Information Management and Indicators Working Group (IMAIG)

12-14 July 2010, International Environment House, Geneva, Switzerland
By Géraldine Boezio

At the initiative of the Global Environment Facility (GEF), UNEP and partners prepared a Medium Size Project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme (TWAP)" to develop scientifically credible methodologies for a global assessment of five transboundary water systems and to catalyse a partnership and arrangements for conducting such a global assessment.

The MSP also entails (i) development of possible indicators to be used; (ii) identification of possible sources of information/data; and (iii) identification of assessment units. The MSP will provide an inventory of major regional and international agencies, available data and existing networks, identification of necessary partnerships for data collection and assembly, and possible identification of capacity building needs that could potentially contribute to the assessment process in the Full-Size Project (FSP).

Five technical Working Groups (WG) have been established at the level of water systems for the development of the methodologies and for the identification of partnership and institutional arrangements for the post MSP phase: (a) Groundwater WG; (b) Lakes/reservoirs WG; (c) River basins WG; (d) Large Marine Ecosytems WG; and (e) Open Oceans WG.

IMAIG has the responsibility for the Data Management, indicators and interlinkages among the five water systems. Each of the five water system WGs has delegated one expert to the IMAIG.

The aim of the IMAIG WG meeting was to bring together the draft methodologies of the five water systems, focusing on their interlinkages, including assessment units/boundaries. The following topics were discussed and agreed:

- linkages among water systems-inputs-outputs between water systems key indicators (state, process, socio-economic, governance, and stress factors with overarching impairment of ecosystems goods and services);
- cross-cutting issues such as: quantity of water, vulnerability due to climate change, nutrients, productivity and mercury;
- inventory of data, sources and programmes for the partnership arrangement in FSP;
- harmonization framework among water systems; and
- development of a data management strategy and system that will incorporate access to existing global databases containing processed and validated data.

"GEO-Cities Tbilisi" process launched

August 18, 2010
By Ron Witt

During the last decade, the cities of the South Caucasus have experienced unprecedented population growth. Thousands of people migrated to large cities in search of work and a better life, or came as refugees after military conflicts. This has created pressure on the urban infrastructure and environment. Due to a lack of resources, monitoring and state of the environment reporting in cities of the South Caucasus has become irregular. In the long run, neglected environmental issues and infrastructure in cities may be manifested in increased human health risks and deteriorating welfare, which could lead to social tensions in cities. This situation may be further strained by a lack of technical capacity in dealing with new challenges.

The United Nations Environment Programme (UNEP) and the Organization for Security and Cooperation in Europe (OSCE), under the umbrella of the Environment and Security Initiative (www.envsec.org), have launched the "GEO-Cities Tbilisi" project "Regional Cities: Environmental Assessment and Capacity Building in Tbilisi". The overall goal of the project is to improve environmental decision-making and promote integrated environmental assessment (IEA) as a key instrument for informed decision-making on important municipal-level environment and security issues. The specific objective of this project is to assess the current environmental status of Tbilisi through the "GEO-Cities Tbilisi" report, and strengthen capacities of the local government in urban environmental planning and management and IEA at the local level.

A multi-stakeholder Workshop on the GEO-Cities methodology on 6-8 July 2010 officially launched the project. Among the participants were representatives of the Ministry of Environment Protection and Natural Resources, Tbilisi City Hall, National Environmental Agen-

cy, Legitimate Government of Autonomous Republic of Abkhazia, Technical University of Georgia, Regional Environmental Center, Aarhus Center, Caucasus Environmental NGO Network, Green Alternative, Greens Movement of Georgia, Centre for Strategic Research and Development of Georgia and mass media.

The Workshop also included a half-day field trip to selected important sites of Tbilisi: the Gldani landfill, a newly-built landfill near the village of Didi Lilo (4.5 km. from Tbilisi), and a closed and environmentally restored illegal construction waste dump in adjacent area to Tbilisi State University.

The Workshop also served as a consensus-building forum on the most important environmental issues of Tbilisi. It was determined that the most important environmental issues in Tbilisi are the following: (1) air pollution, (2) solid waste management, (3) surface water pollution, (4) noise and vibration and (5) decrease of green area/recreational sites, due partially to the spread of uncontrolled construction activities. The list of the most important environmental issues was decided through group discussions and exercises, and will be delivered to the national expert team - the authors of the "GEO-Cities Tbilisi" report. The other important discussions covered forms and methods of stakeholder participation in "GEO-Cities Tbilisi", the current shortcomings of urban environmental governance and management, media coverage of environmental issues, and GEO Tbilisi impact and outreach strategy.

Picture 1. Field trip to Gldani landfill, near Tbilisi. This landfill is soon to be closed.

Picture 2. Participants are interested in the construction and technologies of the newly planned landfilled near the village of Didi Lilo.

Currently the project team is working on selecting the professionals for the national expert team who will be drafting the "GEO-Cities Tbilisi" report. The launch of the "GEO-Cities Tbilisi" report is expected in September 2011. There will be a few more workshops organized for other Georgian cities on the GEO-Cities methodology and the IEA approach. It is expected that "GEO-Cities Tbilisi" will be a good example for other Georgian cities to emulate.

For more information about the "GEO-Cities Tbilisi" project, please inquire with either Mr. Ronald Witt (ron.witt@unepgrid.ch); Ms. Nino Malashkhia (nino.malashkhia@osce.org); or Ms. Nora Mzavanadze@gmail.com .

Picture 3. Lively discussions during GEO Cities Orientation and Methodology Training Working in Tbilisi, 6-8 July 2010.

The EnviroGRIDS project stands out at the GEO Ministerial Summit

Beijing (China), 5 November 2010
By Nicolas Ray and Géraldine Boezio

The Group on Earth Observations (GEO) members and participating organisations came together for the second GEO Ministerial Summit to assess its accomplishments and shortcomings and to finalize the Beijing declaration. UNEP/GRID-Europe and the University of Geneva (UniGe) attended this important event to present the EnviroGRIDS project at the stand "Earth Observation in the Black Sea region" in the GEO exhibition. EnviroGRIDS, whose consortium of 27 partners is coordinated by GRID-Europe and UniGe, was launched in April 2009 with a duration of four years. GEO has made significant progress on developing a standardized, robust and practical classification and map of global ecosystems for terrestrial, marine and freshwater environments. Ecosystem mapping projects continue to advance, such as one on ecosystem vulnerability to climate change, including the task "vulnerability of sea basins" of the GEO workplan, to which the EnviroGRIDS project is the main contributor. The Black Sea catchment suffers from ecologically unsustainable development and inadequate resource management, which has led to severe environmental, social and economic problems. A collaborative management system is being developed to store, analyse, visualise and disseminate crucial data and information on past, present and future states of European seas in order to assess their sustainability and vulnerability. It builds upon the EnviroGRIDS (gridded management system for environmental sustainability and vulnerability) project to develop a Black Sea basin observation and assessment system. EnviroGRIDS relies on modern technology using the largest gridded computing infrastructure in the world and several emerging information technologies that are revolutionizing Earth observation. EnviroGRIDS guidelines have been developed for interoperability, data storage, sensor data use and integration, and remote sensing data use and integration, together with project fact sheets in ten languages. These guidelines provide a firm baseline and a set of recommendations for key technical aspects of the project.

Finally, through the Beijing Declaration, participants called on the United Nations, international organizations, and multilateral and bilateral donor agencies to further contribute to the implementation of the Global Earth Observing System of Systems (GEOSS), to support capacity building for its users (capacity building being a key element of EnviroGRIDS) and to embrace the GEOSS Data Sharing Implementation Guidelines and Action Plan.

From global to local - the scientific base - DEWA/GRID~Europe "Science Day"

University of Geneva - Institut des Sciences de l'Environnement (ISE)
9 December 2010
By Ron Witt

The "Science Day" was a first-time, special event of the DEWA/GRID~Europe 'Partnership', which is composed of the Swiss Federal Office for Environment (CH-FOEN), the University of Geneva (UniGe) and the United Nations Environment Programme (UNEP). The Partnership was founded in 1997 in a unique tripartite agreement, between a Swiss Federal Agency FOEN; an academic institution of the Canton and Republic of Geneva, the University of Geneva; and UNEP.

The Partnership has endured through many changes in each of the three institutions, and is now in the early phases of the fourth, four-year Partnership Agreement. This can be seen as a sign of confidence of all three Partners in the DEWA/GRID~Europe office, and the work being produced over more than twelve years of common effort.

The purpose of the "Science Day" was to expose some of the most prominent activities/projects that have been collectively undertaken, which help to underpin the scientific base of UNEP's work and the programmes of the two other partners, to a much broader audience than traditionally.

The day was organised into four distinct sessions, with global-to-local scientific project presentations, and a final session to discuss and debate the "value-added" of the Partnership; how the whole is greater than the sum of the parts; and how the collective work of the Partnership office contributes to the scientific achievements of each organisations.

Climate change, glaciers and water supply: how GIS and remote sensing can raise awareness

By Pascal Peduzzi

DEWA/GRID-Europe is developing tools to evaluate the role of ecosystem decline and climate change on risk to human population. Changes in glaciers and ice caps are good indicators of climate change and the current trend shows that a majority of the world glaciers have undergone a reduction in their mass at an accelerating rate. Higher temperatures and changes in precipitation patterns have induced an acute decrease in the Andean glaciers, thus leading to additional stress on water supply. To adapt to climate changes, local governments need information on the rate of glacier area and volume losses and on current ice thickness.

In the Andean region, the raining season lasts from three to four months followed by eight-nine months of dry season. Glaciers play a temporal buffer, accumulating snow and ice during the rain season and slowly releasing it during the dry season. Thus, it is vital to understand how quickly this glacier is decreasing.

In 2004, DEWA/GRID-Europe was mandated by the German international cooperation agency (Deutsche Gesellschaft für Technische Zusammenarbeit - GTZ) to evaluate the remaining volume of Coropuna Glacier (Peru) and its rate of recession. Two scientists from DEWA/GRID-Europe and one from the University of Geneva took part of a five-week-expedition in August 2004 in order to measure the ice thickness using geo-radar. Decrease in the ice area was evaluated using satellite images and the remaining volume was estimated using GIS. In 2009, an update on the results was produced and published in The Cryosphere (Peduzzi, Herold and Silverio, 2010). The results from the expedition consist of 10 km of profiles featuring the ice-thickness. The information on thickness was georeferenced using the Ground Positioning Systems (GPS). This allowed modelling the ice volume using a statistical model and a GIS. The model uses correlation between recorded ice-thickness and variables such as slopes, aspect and elevation. The modelled thickness ranges between 20 and 200m, with an average thickness estimated at 80.8 m +/- 16.5 m (at 95% confidence interval). This gives an expected remaining ice volume of 4.62 km3 (+/- 20.3%) – as shown in Figure 1.

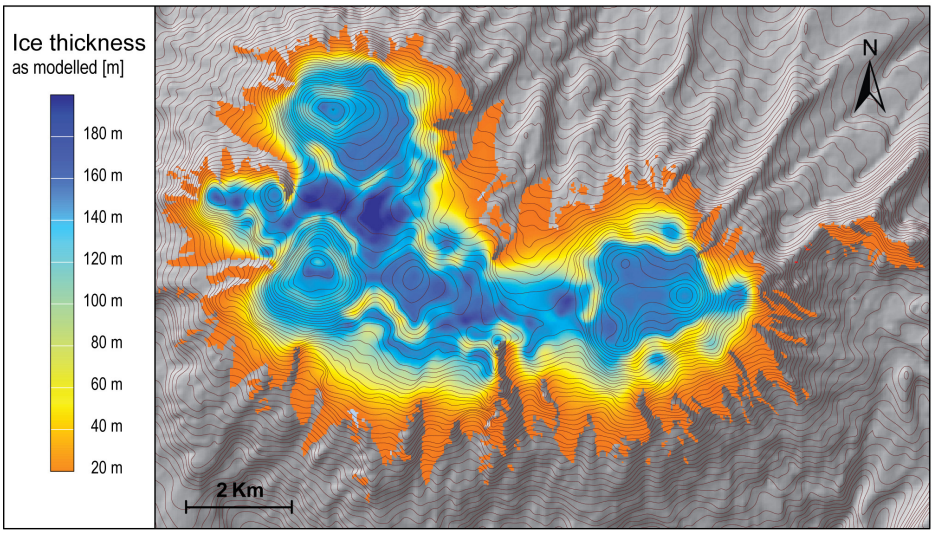

Figure 1 Estimation of ice thickness (model).

DEWA/GRID-Europe generated a Digital Elevation Model (DEM) using a topographic map of 1955 and superimposed recent DEMs derived from different satellites sources and from the Shuttle Radar Topography Mission (SRTM). It was possible to improve the accuracy by statistical corrections. The decrease in ice thickness was estimated to -8.75 and -9.4 m on the ice (i.e. an average of 0.19 to 0.2 m of decrease per year, +/- 0.3 m). However, the margin or error was significant (+/- 13.2 and 14.4 m) and prevented a precise evaluation. The evaluation of ice cover area was conducted using the limit of the glacier of the 1955 topographic map as reference. The map in Figure 2 shows the ice cover changes for the five dates. This remote sensing analysis is based on 1980, 1996 and 2003. In 2009 an update of the situation was made using a 2008 satellite image which confirmed the glacier retreat. It revealed that the Coropuna Glacier shrunk steadily from 122.7 Km2 in 1955 to 48.1 km2 in 2008, i.e. losing more than 60 % of its surface in 53 years.

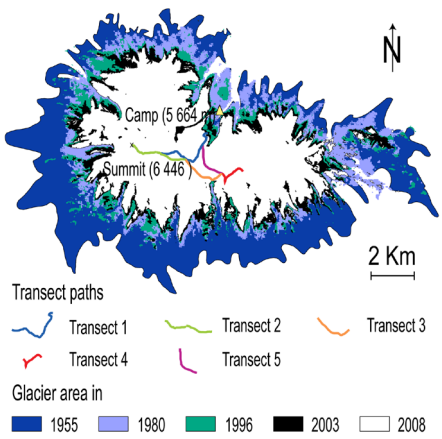

Figure 2 Georeferenced radar profiles and evolution of glaciated area (1955 – 2008).

By plotting glacier area through time (Figure 3) a clear declining trend appears. However, with these observations it is not possible to predict whereas this will follow an accelerating trend (A) corresponding to smaller volume of ice having less inertia, thus shrinking faster. A linear trend (B), or a decelerating trend (C), where the shrinking will be slower when affecting higher altitudes. While scenarios A and B do not make much difference (total decline around 2040), in the scenario C, a small glaciated area would be maintained at the higher altitudes and slowly decline.

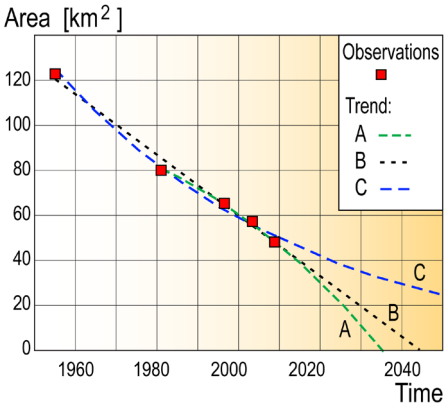

Figure 3 Glacier areas through time and different scenarios.

Following the presentation of the initial results to GTZ and the Peruvian and German Cooperation in Farming and Fishing Services (Cooperación Peruana Alemana de Servicios Agropecuarios – COPASA) in Arequipa in December 2005, several actions were taken. The scientific study helped to raise awareness on the issue of shrinking glaciers and in 2006 COPASA obtained endorsement from GTZ. Results were presented to the United Nations Development Programme (UNDP) who agreed to support through their Global Risk Information Programme (GRIP). Later on, the Inter-American Development Bank (IADB) also joined. These institutions help to introduce new policies for climate change adaptation at both local government and community levels: between 2006 and 2009, the following actions were carried out:

1) a “Changing climate scenario” was developed for the Arequipa region; 2) the socio-economic consequences of climate change were assessed. This led to a climate change adaptation strategy which was included (and implemented) in the Development Plans of six districts of Arequipa State; 3) two urban and rural land use plans were developed in the Viraco and Machahuay districts; 4) guidelines were developed with the Ministry of Agriculture for the incorporation of climate change adaptation in agricultural procedures; 5) several thematic networks of students and teachers have been created and are working on climate change topic; 6) the issue has been brought to the attention of regional institutions, which then produced a regional strategy for climate change adaptation; 7) three university theses have studied climate change at the regional level; 8) four educational brochures were developed and their use approved in primary and secondary schools; 9) a board game was developed on Climate Change Adaptation to help children to learn while playing; 10) five mini reservoirs and fifteen warehouses for forage were built in this area. The recent 2008 Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) image shows that the glacier area continues to shrink, however, the local authorities have now integrated this threat into their development plan. Threat on water supply might be increasing, but efforts are made to reduce the vulnerability of the local population.

More detailed information on methodology and results can be found in the scientific paper published at The Cryosphere: http://www.the-cryosphere.net/4/313/2010/tc-4-313-2010.pdf

Article: Peduzzi, P., Herold, C., and Silverio, W.: Assessing high altitude glacier thickness, volume and area changes using field, GIS and remote sensing techniques: the case of Nevado Coropuna (Peru), The Cryosphere, 4, 313-323, doi:10.5194/tc-4-313-2010, 2010.

GEO-5 Regional Consultation proposes five priority issues for a more sustainable environment in the European region

Chateau de Bossey (Switzerland)

23-24 September 2010

By Géraldine Boezio

Air pollution and air quality, biodiversity, chemicals and waste, climate change, and freshwater are considered the five environmental priorities to be addressed in the pan-European region in the GEO-5 report. This is the main outcome of the meeting organized by the United Nations Environment Programme (UNEP) to prepare the fifth edition of the Global Environment Outlook (GEO-5) on the state, trends and outlook of the global and regional environment. Participants - European representatives of government, civil society, scientists, and academia - came to an agreement on the priority challenges for a more sustainable Europe.

The GEO-5 European Regional Consultation was a unique opportunity for European environmental experts to highlight the most urgent environmental threats in the region and define the key building blocks and steps to advance the regional components of the assessment towards completion in 2012.

Discussions focused on relevant existing policy instruments that could be used to help countries within the region meet their selected internationally agreed goals.

Air pollution and air quality – with the main goal of developing and applying pollution control and measurement technologies for air pollution sources, developing alternative environmentally sound technologies and observing and assessing sources and extent of transboundary air pollution (Agenda 21, chap.9, para.27).

Biodiversity – with the main goal of adopting measures relating to the use of biological resources to avoid adverse impacts on biological diversity, and protecting and encouraging customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements (Convention on Biological Diversity, art.10).

Chemicals and waste – with the main goal of sound management of chemicals throughout their life cycle and of hazardous wastes for sustainable development and for the protection of human health and the environment (Johannesburg Plan of Implementation, para. 23).

Climate change – with the main goal of achieving stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (United Nations Framework Convention on Climate Change (UNFCC), art. 2).

Freshwater – with the main goal of improving the efficient use of water resources and promoting their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving or restoring ecosystem and their functions (Johannesburg Plan of Implementation, para. 26 c).

Concluding the meeting, Mr. Matthew Billot (UNEP's Head of Global Environmental Outlook (GEO) Unit), said that "The regional consultations play a very important role in the GEO process and invaluable inputs were received from a wide range of stakeholders. The objectives of the meeting were fully met and UNEP considered the consultation a great success".

Participants Day 2