United Nations A/AC.105/913

General Assembly

Distr.: General
1 April 2008

Original: English

[Start1]

Committee on the Peaceful Uses of Outer Space
Fifty-first session
Vienna, 11-20 June 2008

Report on the United Nations/Argentina/Switzerland/European Space Agency Workshop on Sustainable Development in Mountain Areas of Andean Countries

(Mendoza, Argentina, 26-30 November 2007)

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V.08-52348 (E) 200508 210508

I. Introduction

A. Background and objectives

1. At the World Summit on Sustainable Development, held in Johannesburg, South Africa, from 26 August to 4 September 2002,[1] Heads of State and Government reaffirmed their commitment to the full implementation of Agenda 21,[2] which had been adopted at the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil, from 3 to 14 June 1992. They also committed themselves to achieving internationally agreed development goals, including those contained in the United Nations Millennium Declaration (General Assembly resolution 55/2). The Johannesburg Declaration on Sustainable Development[3] and the Plan of Implementation of the World Summit on Sustainable Development[4] were both adopted at the World Summit.

2. In its resolution 54/68 of 6 December 1999, the General Assembly endorsed the resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development",[5] which had been adopted by the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999. UNISPACE III had formulated the Vienna Declaration as a nucleus of a strategy to address future global challenges using space applications. In particular, in the Vienna Declaration, the States participating in UNISPACE III noted the benefits and applications of space technologies in addressing the challenges to sustainable development, as well as the effectiveness of space instruments for dealing with the challenges posed by the depletion of natural resources, loss of biodiversity and the effects of natural and anthropogenic disasters.

3. The implementation of the recommendations contained in the Vienna Declaration supports the actions called for in the Johannesburg Plan of Implementation to strengthen the capacities of Member States, in particular of developing countries, in order to improve the management of natural resources by increasing and facilitating the use of remote sensing data and increasing access to more affordable satellite imagery.

4. At its forty-ninth session, in 2006, the Committee on the Peaceful Uses of Outer Space endorsed the schedule of workshops, training courses, symposiums and conferences of the United Nations Programme on Space Applications for 2007.[6] Subsequently, the General Assembly, in its resolution 61/111 of 14 December 2006,

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[1] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 1, annex, para. 1.

[2] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992* (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: *Resolutions adopted by the Conference*, resolution 1, annex II.

[3] *Report of the World Summit on Sustainable Development*, chap. I, resolution 1, annex.

[4] Ibid., chap. I, resolution 2, annex.

[5] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1.

[6] *Official Records of the General Assembly, Sixty-first Session, Supplement No. 20* (A/61/20), para. 87.

endorsed the schedule of activities of the Programme on Space Applications for 2007.

5. Pursuant to General Assembly resolution 61/111, the United Nations/Argentina/Switzerland/European Space Agency Workshop on Sustainable Development in Mountain Areas of Andean Countries was held in Mendoza, Argentina, from 26 to 30 November 2007. The National Commission for Space Activities (CONAE) of Argentina hosted the Workshop on behalf of the Government of Argentina. The Workshop was co-sponsored by the Government of Switzerland and the European Space Agency (ESA) and was the third in a series of activities on sustainable development in mountain areas (see the report on the United Nations/Austria/Switzerland/European Space Agency/International Centre for Integrated Mountain Development Workshop on Remote Sensing in the Service of Sustainable Development in Mountain Areas, held in Kathmandu from 15 to 19 November 2004 (A/AC.105/845), and the report on the United Nations/European Space Agency/International Centre for Integrated Mountain Development Expert Meeting on Remote Sensing Projects for the Hindu Kush-Himalayan Region, held in Kathmandu from 6 to 10 March 2006 (A/AC.105/870)).

6. Mountain areas are environmentally delicate, the source of freshwater for more than half of humanity, rich in biological and cultural diversity, places of spirituality for many societies and recreation sites for millions of people around the world. Yet mountain areas have unique problems that must be solved. Precious mountain ecosystems are being affected by climate change, exploitative mining, environmental degradation and conflict. As a consequence, mountain people are still among the world's poorest and most disadvantaged. Often isolated and marginalized, many mountain people have little influence over the decisions that affect their lives and environments.

7. The population of mountain regions is normally concentrated in valleys and the livelihoods dependent on agriculture or tourism. It is important for policy for the development of mountain areas to be environmentally, economically and socially sustainable. In reality, however, this is not often achieved: for example, landslides are caused by overused or eroded soils and the destruction of natural forest, while the natural topographical features mean that mountain areas are susceptible to floods and avalanches, all of which have disastrous effects in the overpopulated valley areas. Shortages of safe water sources are a problem in mountain areas as a result of natural disaster and human impact. Climate change in mountain areas can reduce the stability of rock or/and permafrost, thereby increasing the probability of landslides. Drought and forest fires are also experienced in those areas.

8. Sustainable development requires the optimal management of natural resources and depends upon the availability of reliable and up-to-date information at the national, regional and international levels. Remotely sensed data can provide a view of the Earth for many studies that require spatial and temporal observations such as inventory, surveying and monitoring for agriculture, hydrology, geology, mineralogy and the environment. Remote sensing is generally integrated with other disciplines such as photogrammetry, cartography, geodetic reference systems, geographical information systems (GIS) and global navigation satellite systems (GNSS).

9. Although it has considerable potential, the remote sensing of mountain areas does have some technological constraints, which need to be defined and considered in the planning of any capacity-building activities. In addition, education and distribution of the data products play a pivotal role in the effective adoption of remote sensing applications for sustainable development.

10. Effective communications in mountain regions are essential to ensuring adequate sharing of the information that is essential for sustainable development, for communication during disaster management and for provision of health and education services to remote areas. Terrestrial communications in mountainous regions are often expensive, unreliable and difficult to access. Satellite communications can offer a cost-effective solution and have a crucial role to play in mountain areas, not only in the distribution of data for sustainable development, but also in disaster management, education and health care.

11. GNSS are indispensable in the application of remote sensing for sustainable development and in disaster management. For example, GNSS are useful for accurate field verification of remote sensing data and for ground-based collection of data for sustainable development.

12. The Workshop on Sustainable Development in Mountain Areas of Andean Countries built upon the work carried out by the Office for Outer Space Affairs of the Secretariat in the framework of the United Nations Programme on Space Applications.

13. The primary objective of the Workshop was to discuss the potential uses of remote sensing and other space-related technologies in facilitating sustainable development in mountain areas with the aim of developing priorities for building capacity in remote sensing for the benefit of mountainous regions. A further objective was to define follow-up activities that would test and demonstrate the appropriateness of space technology for sustainable development in mountain areas.

14. The present report gives the background to and describes the objectives of the Workshop and provides a summary of some of the presentations and observations made by the participants.

B. Programme

15. At the opening of the Workshop, introductory and welcoming statements were made by representatives of CONAE, the Government of Switzerland, ESA and the Office for Outer Space Affairs.

16. Three of the five days of the Workshop were devoted to presentations on activities carried out by the participating institutions, one day was devoted to the discussion of follow-up actions and projects and one day was devoted to a field trip to the Valle de Horcones, in the Andes, near Mendoza.

17. The programme of the Workshop included seven sessions, at which presentations were given on the following issues: (a) the Andes: genesis and space technology; (b) natural and cultural heritage sites in the subregion; (c) natural resources and the environment; (d) hazards and risks; (e) territorial planning; (f) economic activities and sustainability; and (g) cooperative and financial

mechanisms. Two additional sessions provided opportunities for participants to discuss issues concerning regional and international cooperative mechanisms and resources for implementing projects. On the fourth day, three working groups were formed to analyse the following topics, which were of interest to Andean countries: hydrology, agriculture and mining resources. The working groups also met to outline project proposals.

18. During the first three days of the Workshop, invited speakers from both developing and developed countries delivered a total of 48 presentations, which focused on national, regional and international projects and initiatives involving the use of space technology applications for improved management of natural resources and environment and the contribution of space technology to sustainable development programmes in the mountain areas of Andean countries.

C. Attendance

19. A total of 73 scientists, educators, decision-makers and engineers from the following countries participated in the Workshop: Argentina, Austria, Bolivia, Chile, Colombia, Ecuador, Nepal, Peru and Venezuela (Bolivarian Republic of). Representatives of the following organizations also participated in the Workshop: ESA, the International Centre for Integrated Mountain Development (ICIMOD), the Mountain Forum and the Office for Outer Space Affairs.

20. Funds provided by the United Nations, the Government of Argentina, the Government of Switzerland and ESA were used to defray the costs of air travel, daily subsistence allowance and accommodation for 25 participants.

II. Summary of presentations

21. At the presentation sessions, participants learned how space technology could be used for sustainable development in mountain areas of Andean countries and heard about success stories and potential applications. The discussion sessions that followed focused on current trends, recent innovative developments and initiatives and institutional aspects requiring further consideration.

22. The present section contains a summary of the main issues addressed by some of the invited speakers during the thematic sessions. Further information on the Workshop programme, background materials and presentations is available on the website of the Office for Outer Space Affairs (http://www.unoosa.org).

A. The Andes: genesis and space technology

23. It was noted that, since 2004, the policy of ESA and the Office for Outer Space Affairs had been to support regional conferences for sustainable development in mountain areas. Satellite-based remote-sensing instruments were appropriate for studying and managing resources in such areas. Combining optical and radar imagery was especially relevant in cloudy areas. An appropriate selection of space data should be made and the adoption of policies facilitating access to information should be encouraged. The joint project of ESA and ICIMOD on the application of

data from the Environmental Satellite (ENVISAT) of ESA in the Himalayan Hindu-Kush region included ESA Earth observation missions and Global Monitoring for Environment and Security services. Radar interferometry techniques were appropriate for mountain areas. Differential interferometry techniques were also useful for measuring millimetric displacements in the terrain.

24. In Argentina, CONAE is in charge of carrying out the national space programme. As part of the programme, three satellite series are being developed, each of which differs according to the type of the main instruments it carried on board: (a) the Scientific Applications Satellite (SAC) series, with instruments for the optical and passive microwave spectra; (b) the Observation and Communications Satellite (SAOCOM) series, with active instruments for the microwave spectrum; and (c) the Satelite de Alta Revisita (SARE) series, which are frequently revisiting satellites both for technology validation and Earth sciences objectives.

25. It was reported that Latin American cooperation activities carried out by CONAE were related to the provision of space information, the development of training and early warning models and the promotion of cooperation with approximately 49 institutions from 11 countries in the region. The Mario Gulich Institute for Advanced Space Studies was an entity managed jointly by CONAE and the University of Córdoba that promoted a space science perspective in multidisciplinary projects involving multiple institutions.

26. It was noted that SAC-C was the first Argentine Earth observation satellite; launched on 21 November 2000, it had been operating for more than six years.

27. The Aquarius/SAC-D satellite carried out a science mission, conducting measurements over Argentina and contributing to global investigations on the atmosphere, the oceans and the effects of technogenic activities and natural phenomena on the environment in accordance with the strategic plan of the Argentine national space programme. Aquarius/SAC-D had been developed within the framework of an international partnership with the Italian Space Agency (ASI), the Centre national d'études spatiales of France, the National Institute of Space Research of Brazil and the Canadian Space Agency.

28. It was noted that the Italian-Argentine Satellite System for the Management of Emergencies (SIASGE) was dedicated to preventing, mitigating and managing natural disasters, focusing on floods, landslides, fires, seismic events, volcanic eruptions and epidemiology. The system, which required combined observations of the same scene in X- and L-bands, would be effective for floods, soil and ice monitoring and for hydrology and geology.

29. It was reported that the morphology and mega structures of tectonic and plate movements that had given birth to the Andes were still undergoing changes, as shown by the data gathered by various satellites. Space science information had been useful in the study of the characteristic movements of the plates throughout the region, in general, and of manifestations such as volcanism in the central Andean area in Peru, in particular. Interferometric studies had been useful in seismic areas of the region. Aconcagua Mountain was another example of those movements. Other effects of such movements had taken place in Santiago.

B. Natural and cultural heritage sites in the region

30. It was stated that the Main Andean Road (*Qhapaq Ñan*) was the most important technological work done in pre-Hispanic America and consisted of a network of roads of approximately 23,000 km. The roads that formed that network could be seen in satellite images. A project was being developed in Ecuador to strengthen procedures for the identification, registration, administration, management and control of the Main Andean Road by using space technologies; in so doing, the project also aimed to improve the quality of life of the communities linked to the Road. The institutions participating in the project were: the Ministry of Foreign Affairs and the Ministry of Tourism and the Environment of Ecuador, the Council for the Development of the Nationalities and Peoples of Ecuador, the Military Geographical Institute, the Centre for the Integrated Surveying of Natural Resources by means of Remote Sensing and the National Institute of Cultural Heritage of Ecuador.

31. It was noted that the capacity to carry out an inventory and to monitor glaciers located in the southern area of Argentine Patagonia had been developed using space imagery. The methodology used was based on the digital image processing of data collected during the period 1981-2006 by the Landsat Multispectral Scanner, the Thematic Mapper and the Enhanced Thematic Mapper.

32. The conclusions of the project were that: (a) some glaciers, including Upsala, Onelli, Bolados, Frías and Dickson, whose front sides were based on lakes, had seen their glacier tongues recede in the last two decades; (b) several slope glaciers, including Murallón, had shown serious degradation; (c) several glaciers with areas smaller than 2 square km had practically disappeared; (d) some glaciers, including Viedma, had become significantly smaller, especially in ablation areas; (e) there were very clearly defined moraines in valleys between glaciers, indicating further disintegration in the higher parts of mountain ranges due to erosion from exogenous agents; (f) glaciers at the same latitude were undergoing very different changes.

33. The following recommendations were made: (a) monitoring activities using optic and radar imagery should continue; (b) the dynamics, mass balance and glacier basin should be studied at the field level; (c) automatic meteorological facilities should be installed in main glaciers; (d) a glacier inventory should be developed and updated with the assistance of Global Positioning System technology in the field.

34. The San Guillermo Biosphere Reserve had received funding from the Global Environment Facility and the National Parks Administration of Argentina to study biological and cultural diversity using remote sensing and GIS technology. Space geo-referenced information had been generated on 13 biological, physical and cultural aspects. The data gathered from digital imaging processing, digital cartography and GIS had produced baseline information for the monitoring and management of the Reserve.

C. Natural resources and the environment

35. It was noted that changes in climate occurred in cycles lasting between 20,000 and 400,000 years. Since 1856, data had shown a rise in the average temperature of the surface air. In Argentina, there were two well differentiated

climate zones: (a) a humid zone in the east, with precipitation of more than 800mm per year; and (b) an arid Andean zone in the central and western parts of the country, where rainfall had decreased and glaciers had receded. It was important to develop future scenarios for the Andean subregion. The Atuel, San Juan, Colorado and Neuquén rivers had experienced a clear negative trend in annual water flow since the 1980s and annual increases in the average temperature were expected towards the end of the century. It was also expected that levels of rainfall would vary substantially from season to season throughout Argentina.

36. The possible impact of climate change on the distribution of groups of plants and birds in the northern Andes had also been evaluated and different scenarios had been developed to analyse possible trends with regard to the loss and renewal of different kinds of species. Conclusions: (a) the impact of climate change on the Andean fauna and flora might be extremely severe; (b) at the regional level, fauna and flora concentrated in certain areas would be most affected; (c) a high percentage of species endemic to the *páramo* ecosystem and xerophilous forests was expected to become extinct; (d) birds and plants tended to live in smaller areas as their climatic niche contracts; (e) close to 35 per cent of birds and 60 per cent of plants would disappear by 2080.

37. A joint project between Argentina and Chile to monitor changes in snow, glacier and wet meadow coverage in the high Andean hydrological basins was being developed with the participation of academic and water management institutions in the two countries. The objective was to collect space data in real time in order to identify and evaluate (spacially and temporally) snow, glacier and wet meadow coverage. The target study area also included rivers in high mountains whose waters come from snow and glaciers. Currently, the water flow was increasing significantly during summer, bringing with it a serious risk of floods. Those rivers were the only source of water for human consumption and economic activities in those arid and semi-arid climate zones. Argentine SAC-C satellite images were being used in the project.

D. Hazards and risks

38. It was noted that, in the Bolivarian Republic of Venezuela, the Maracaibo Basin, covering an area of 92,789 square km, included high and low lands, mountain slopes, valleys, terraces, alluvial plains, desert areas and areas of abundant vegetation. It also contained mineral deposits and areas suited for agriculture. Moreover, there were important water flows and lagoons, as well as Lake Maracaibo. The area was an important source of crude oil and the site of significant agricultural activity and high population density. An environmental sensitivity model had been designed and developed based on physical, natural and socio-economic attributes and variables. The model, which could be seen as an additional GIS layer, could be used as a reference document for those Government offices responsible for planning, ordering and assessing the territory of the Basin. The model made it possible to assess vulnerable areas at different levels and, therefore, to directly influence the quality of life of people living within the Basin.

E. Territorial planning

39. It was stated that the strategic policy of the Government of the Bolivarian Republic of Venezuela was aimed at promoting sustainable human development. That meant an improved territorial income distribution based on the best profit from the potential of each region. In that regard, an environmental assessment had been conducted of the natural and socio-economic conditions for the management of the Venezuelan territory regarding risks and indigenous development. A GIS-based risk analysis, complemented by satellite images, had been used to identify sites where landslides and floods might occur (pre-inventory map). On the ground, identified sites were verified in the pre-inventory map. Key variables had also been identified by comparing the inventory map with the variable maps. A map of at-risk areas had been generated from the assessment of key variables. An analysis of vulnerability had been carried out. Risk had been calculated on the basis of threat and vulnerability and, finally, the risk map had been generated.

F. Economic activities and sustainability

40. It was noted that ICIMOD was assessing new strategies and programmatic frameworks. Many areas of the Himalaya mountain range were isolated, forgotten, vulnerable and poor. The Himalayas were the origin of all major Asian rivers and provided water to 1.5 billion people. The downstream impacts were greater and increasing all the time. The mission of ICIMOD was to facilitate the equitable and sustainable distribution of welfare among the mountain population of the Hindu Kush Himalaya, to support sustainable development through regional cooperation and to support the reduction of poverty, thus helping the local population to adapt to global climate change.

41. A cooperation project was being implemented jointly by ICIMOD and ESA in the region to develop methods for making maps to facilitate the detection of changes in land cover using data produced by a Medium Resolution Imaging Spectrometer (MERIS); that was also the method used to draw maps of Nepal. Also, methods used by the Food and Agriculture Organization of the United Nations to classify land cover had been employed. Teaching material and training courses for countries in the region had also been provided.

42. The Centro de Información de Recursos Naturales (CIREN) of Chile must, in accordance with its objectives and new Government policies, generate and integrate data on the agricultural and natural resources of Chile and make such data available to all relevant entities (for example, to the development agencies of Chile and other States) through the use of information technologies, Earth sciences and the settlement of cooperation agreements. Projects on the following topics had been carried out: (a) the fragility of mountainsides with fruit crops in the Valparaíso Region; (b) current erosion and fragility in the arid coastal zones (in the O'Higgins and Maule regions); and (c) the homogeneous zones of underground water.

43. The Globally Integrated Environmental Assessment Modelling (GLEAM) tool was a new system that uses geographical information for the administration and assessment of land use. In Bolivia, it had been used to integrate satellite data with environmental, agricultural and economic digital models in a database to support

institutions, programmes and projects involved in promoting the agricultural development of the country. GLEAM integrated different kinds of data (GIS, weather, soil, prices, production etc.) and analysed the current land use to formulate, assess, monitor and manage agricultural development projects. It was used to assess land use in the country, within the framework of an agreement signed with the Ministry of Agriculture of Bolivia. In short, GLEAM was a computerized tool for decision-making and planning.

44. It was noted that the mining sector in Peru was currently attractive to investors. In mining exploration, it was important to know the variety and concentration of metals in the area. Images collected by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) were useful for generating digital elevation models, which would allow for the identification of structural features favourable to mineralization and, therefore, of the location of alteration zones. The classification of Mixture Tuned Matched Filtering of alunite, pirofilite, chlorite and muscovite from ASTER images was an additional tool for the location and mapping of hydrothermal alteration zones.

45. It was stated that, in order to promote sustainable development, it was important to provide telecommunications technology to human settlements. The "pueblo plan" was a project to enable satellite-based communication among small towns and villages with no communication infrastructure. The project provided people with access to the Internet and e-mail in a cost effective way, while also providing unlimited geographical coverage (nationally and internationally), a high degree of flexibility and network homogeneity, showing optimal availability and security of transmitted data. The "pueblo plan" was a tool used to establish a communication infrastructure without borders for the region.

G. Cooperation and financial mechanisms

46. The Mountain Forum was a global network working for the sustainable development of mountain areas. Created in 1998 as a global network to follow up on the recommendations contained in chapter 13 of Agenda 21, the Mountain Forum promoted the exchange of knowledge and the provision of mutual support and help for the development of mountain areas in a way that was equitable and ecologically sustainable. It had a secretariat (in Nepal), regional centres and an independent council formed by elected members. A worldwide network had been established to provide an active platform for dialogue and data exchange, as a result of which awareness of sustainable development in mountain areas had been raised among 3,000 individuals and 400 organizations.

47. It was reported that the following issues, projects and activities relevant to the Workshop on Sustainable Development in Mountain Areas of Andean Countries had been addressed at the Fifth Space Conference of the Americas, held in Quito from 25 to 28 July 2006: (a) use of Earth observation systems for early warning, rescue and the mitigation of the effects of disasters; (b) thematic networking and regional inter-institutional communication through the Internet, integrated into a global platform for disaster reduction supported by the United Nations; (c) integration and regional coverage of the Cotopaxi, Cuiabá and Córdoba stations and the provision of space data online; (d) regional workshop on disasters, including volcanic and

seismic risks and landslides; (e) implementation of a data distribution system for spatial planning, basin management and the management of coastal and ocean zones; (f) support to the project Main Andean Road (*Qhapaq Ñan*) and its nomination for inclusion in the World Heritage List of the United Nations Educational, Scientific and Cultural Organization; and (g) support to the proposal of monitoring and conserving the Galapagos Islands.

48. The Department of Sustainable Development of the Organization of American States (OAS) had conducted the following programmes and projects: (a) a strategic action plan for the Bermejo river basin; (b) a project for sustainable land management in the transborder area of the Gran Chaco ecosystem; (c) a project for the protection and sustainable development of the Guarani aquifer system; (d) a project for the implementation of conservation and sustainable development practices in Alto Paraguay/Pantanal; (e) a project on integrated management of transborder water flows through the Amazon river basin; (f) a project on an inter-American data network on biodiversity; and (g) a project on an inter-American network of hydro resources.

49. It was noted that the Committee for the Sustainable Development of the Mountain Regions of Argentina had been formed on 2 May 2005 with the objective of creating an institute that would promote discussion among all public and private entities involved and the implementation of strategies for conserving mountain areas in Argentina. The ultimate aim was to raise adequate resources and look for synergies for successful joint action.

III. Conclusions

A. General conclusions

50. On the basis of discussions held and presentations given, three working groups were established at the Workshop to generate ideas for projects in the following areas: hydrology, agriculture and mining resources. The participants agreed:

(a) To prepare a proposal on the use of remote sensing for the sustainable development of the Andean subregion. Many components of such a proposal could come from the Workshop. It was suggested that the proposal be entitled “natural resources environmental management and socio-cultural sustainability in the Andes”. CONAE would be in charge of collecting and distributing information for the proposal;

(b) To request ESA and CONAE to assist in providing satellite images for use in regional projects (the importance of ASTER satellite data and the need for improved access to the information were emphasized);

(c) To establish a website, a participants’ network and an e-forum for all countries involved in the proposal;

(d) To share the outcome of space data applications available to ESA and CONAE with organizations such as the Mountain Forum and upload such information to the websites of other entities for geographical information technologies applications to enrich the content of those websites;

(e) To promote an active discussion of problems faced in the Andean area in international forums and use the Mountain Forum as a link to other regional entities (including the Inter-American Development Bank, OAS, the Andean Initiative, the Mountain Partnership, the Andean Páramo Project and the Adelboden Group on Sustainable Agriculture and Rural Development in the Mountain Regions) and initiatives such as the SARD-M Project;

(f) That OAS mechanisms should be used to present proposals and projects;

(g) That the Andean countries should promote cooperation agreements and coordination between official institutions from the mining, hydrology and soil sectors;

(h) That the historic value of the Andean subregion and its culture should be maintained;

(i) That a common geographical reference system and set of methodologies should be adopted.

B. Conclusions of the working group on hydrology

1. General objective

51. The general objective of the hydrology sub-project was to utilize space technology to reduce uncertainties in climatic and hydrologic scenarios so that the scenarios could be used in planning and developing policies and in deciding necessary steps.

2. Specific objectives

52. The specific objective of the hydrology sub-project was:

(a) To establish an inventory of glaciers and conduct studies of relevant water basins in the Andean subregion in order to estimate the availability and size of water resources and the risk posed to communities in the subregion;

(b) To contribute to territorial planning activities aimed at optimizing the sustainable use of the resources;

(c) To improve conservation mechanisms in certain basin headwaters;

(d) To study protected high mountain areas, including basin headwaters;

(e) To contribute to biophysical vulnerability studies in Andean water basins.

C. Conclusions of the working group on agriculture

53. The working group on agriculture addressed a wide range of activities, including farming, stockbreeding pastureland and forestation.

1. General objective

54. The general objective of the agriculture sub-project was to guarantee data collection for the benefit of those active in agriculture.

2. Future actions

55. In the future, the agriculture sub-project should aim:

(a) To analyse alternatives to Landsat images and the development of appropriate training activities;

(b) To study the effects of climate change in terms of changes to farming practices;

(c) To study climate change and its impact on the surface of the soil;

(d) To research limitations on intensive farming activities (precision agriculture).

D. Conclusions of the working group on mining resources

1. General objectives

56. The general objectives of the mining resources sub-project were to determine the baseline potential of the mining resources in the Andean subregion using space data and to design a way for those resources to be used sustainably, in harmony with the environment.

2. Specific objectives

57. The specific objectives of the mining resources sub-project were:

(a) To create an inventory of all industries and strategic mining resources in the Andes, using optical and radar data;

(b) To determine the impact of mining activities using satellite data.

3. Future actions

58. In the future, the mining resources sub-project should aim:

(a) To initiate a geosemantics project as a tool for producing and exchanging information;

(b) To define a methodology and standards for processing space information so as to identify mining resources and outline an environmental baseline;

(c) To elaborate a mining resource management model.