

10 Years of High Mountain Remote Sensing Cartography (HMRSC)

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Satellite-based remote sensing of the earth was begun for civil applications for the first time in history in the year 1972. In July of that year NASA launched its first Earth Resources Technology Satellite, ERTS-1, later named Landsat-1, into a near-polar, sun-synchronous orbit. The earth resources detection and monitoring satellite became operational immediately after a period of experimental testing. A good deal of the success of the Landsat program is due to the efforts of Dr. William Nordberg, an Austrian. He studied Physics at the University of Graz, Austria, and after completion of his studies he joined NASA in the USA. In commemoration and in recognition of his outstanding contributions to the application of remote sensing of earth from spacecraft an "International Willi Nordberg Symposium" was held in Graz from September 7 to 9, 1987 (BUCHROITHNER and KOSTKA 1988).

The earth observation satellite SPOT-1, which was conceived and designed by the French CNES, was launched in 1986. Operational mapping of the earth in 3D became feasible for the first time employing push-broom scanning and pointable optics. Space-borne remote sensing has become an increasingly interesting tool for applications in high mountain cartography with the passing of the years. Many problems in geometric and radiometric processing of space-borne images had first to be solved. Furthermore, operational procedures for topographic and thematic mapping had to be developed and tested in case studies later. As a matter of fact an international high mountain test site, called TADAT – Tauern Dachstein Test Area –, was selected in the Austrian Alps at the end of the 1980s. An Austrian research initiative submitted a comprehensive research program to the Austrian Science Foundation referring to this test site. The proposal was accepted and financially supported. The results of this study were quite promising (KOSTKA and BUCHROITHNER 1994) and this endeavor eventually led to the organization of a Symposium on High Mountain Remote Sensing Cartography, later named **HMRSC I**, with its general topic on applications of remote sensing in tasks of high mountain cartography.

An international group of some 35 participants gathered in the small former mining town of Schladming at the foot of the impressive Dachstein massif, which is located in the northwest of Styria, Austria, from September 26 to 28, 1990. Two days of interesting and efficient information exchange were followed by an exhaustive, long excursion day up to the glacier station on the Dachstein range and into the Riesach Valley of the Schladming Tauern range. For a number of reasons the proceedings of HMRSC I were published only several years after the symposium was held (BUCHROITHNER 1996).

One of the conclusions of the first symposium was that high mountain regions, the focus of our scientific investigations, must not only be studied by means of remotely sensed imageries but they must be investigated in situ for gathering ground truth data and field evidence. This idea was further strengthened through the subsequent biannual HMRSC symposia.

The Second Symposium on High Mountain Remote Sensing Cartography (**HMRSC II**) was jointly organized by the Institute of Remote Sensing Applications, Chinese Academy of Science, P.R. China, the Institute for Image Processing and Computer Graphics, Joanneum Research Graz, Austria, and the Institute of Geology, University of Vienna, Austria. Oral presentations were not only given in Beijing, but also in Lhasa, the capital city of Tibet, and in Kathmandu, Nepal. The host in Kathmandu was the International Center for Integrated Mountain Development (ICIMOD). An excellent exhibition of various maps and satellite imageries was also an integral part of HMRSC II. The international participants of the symposium were very much impressed by the field excursion, which was not only very informative but also quite strenuous, and in some instances adventurous. Starting from Beijing the city of Lhasa was reached by airplane with a stopover in Chengdu. A bus, a truck and several 4-WD cars were the means of transport from Lhasa to Rongbuk Monastery (5030 m), close to the Mt. Everest Base Camp, and further on to the Friendship Bridge at the border between Tibet and Nepal. Due to mountain hazards, e.g. landslides and mudflows, several hundred meters of road to Kathmandu had been severely damaged or even destroyed – the participants had to cover these distances by foot and they also had to change vehicles several times. The proceedings of HMRSC II were published by the Astronautic Publishing House, Beijing, P.R. China (LIU JIYUAN and BUCHROITHNER 1993).

The Third International Symposium on High Mountain Remote Sensing Cartography (**HMRSC III**) was organized by an international committee headed by Saturnino Leguizamón, chairman of HMRSC III and held from November 7 to 13, 1994. The meeting took place in the beautiful city of Mendoza, located at the foot of the Andes in Argentina. The Institute for Applied Research in Space Sciences (IIACE-CONAE), Mendoza, was responsible for the local organization. The oral presentations of the participants were outstanding and triggered fruitful discussions. The highlight of the post-symposium field excursion was the crossing of the Central Andes south of the highest mountain of the Americas, the 6959 m high Mt. Aconcagua, which brought the group to the capital city of Chile, Santiago. After having crossed the Coastal Cordillera the field excursion finally closed in Valparaíso, a

city located on the Pacific Coast.. The closing ceremony of HMRSC III held at Viña del Mar is very fondly remembered. The proceedings of HMRSC III were published in a special issue of IACE (LEGUIZAMÓN 1995).

The next symposium, **HMRSC IV**, took place in Europe once again, this time in Scandinavia. Oral presentations of more than 30 researchers from 16 countries and 5 continents were given from August 19 to 21, 1996 during various technical sessions at the University of Karlstad in southern Sweden. The post-symposium excursion, well organized by the chairman of the organizing committee G. BAX, led the participants to the northern parts of Scandinavia, north of the polar circle. Receiving stations of satellite data and research facilities were visited in Kiruna (Sweden) and Tromsø (Norway). Detailed field studies were devoted to a geological transect through the "Scandinavian Caledonides" starting from Kiruna, passing through Abisko National Park and the geological formations of Torneträsk, reaching the city of Narvik and finally ending at the Lofoten Islands. The proceedings of HMRSC IV were published both as an "analog" B/W paper version and in digital format with colored figures (BAX 1997). The latter is provided on CD-ROM or can be downloaded from Internet (<http://www.nature.kau.se/nhc/hmrsc4/>).

The Fifth Symposium, **HMRSC V**, was held at the Humboldt State University in Arcata from August 23 to 25, 1998. Arcata is located on the Pacific Coast in northern California, USA. Humboldt State University is well known for its environmental focus in teaching courses and research work. This is why Geographical Information Systems (GIS) and remote sensing play an important role at the University. The interest of the participants was directed towards this approach to the subject. The oral presentations during the technical sessions covered a broad range of topics from theoretical studies to application oriented work, and future earth observation scenarios. The organizing committee intends to publish the proceedings of HMRSC V in 2000, or 2001 at latest. Traditionally, the paper sessions were followed by a several days long field excursion which allowed available images and maps to be compared with field evidence in the areas visited. The variety of different landscapes in Northern California was very much appreciated by the participants, since elements of scenic high mountain topography were also included in the itinerary. The visiting program lists the following places: Humboldt Redwoods State Park, Napa Valley, Lake Tahoe, Squaw Valley, Mono Lake, and Yosemite National Park.

The Sixth Symposium on HMRSC set a "milestone" within the HMRSC symposia series, marking 10 years (1990-2000) of fruitful work in high mountain remote sensing cartography. **HMRSC VI** took place in three different countries in East Africa, i.e., Ethiopia, Kenya and Tanzania. The proceedings of this last symposium are the content of this volume. Moreover, a "field guide" of the highly interesting field excursions is attached to the proceedings.

It was not only possible to study the technical development of space-borne remote sensing in depth but also to apply, test and evaluate new techniques of mapping in various tasks of HMRSC in many different parts of the earth within the framework of this series of exceptional symposia on HMRSC. Many new solutions have been proposed to the scientific community and, furthermore, the possibilities of remote sensing applied to high mountain areas were clearly outlined. It is certainly true that scientific research work on this subject was at the very beginning in 1990. The International Cartographic Association (ICA), however, acknowledged the importance of high mountain cartography in 1999 by installing a corresponding Commission on Mountain Cartography (CMC) within ICA. Current chairman of the CMC is L. HURNI, ETH Zurich, Switzerland.

It may finally be stated in summary that through this unique series of symposia from HMRSC I to VI it was possible to study the activities of high mountain remote sensing cartography from the beginning of three-dimensional mapping of high mountain relief down to the sophisticated, computer-based presentations of today and to give considerable support to its technical and scientific development.

Remote sensing, which was linked with Graz 30 years ago, through the person of William Nordberg, and was presented internationally in the series of HMRSC symposia over the past decade, will surely continue to play an active role in high mountain research in Graz. The organizations involved are the Graz University of Technology, the University of Graz, Joanneum Research Graz, and the Austrian Academy of Sciences.

References

- BAX, G. (Ed.), 1997: Proceedings of the 4th International Symposium on High Mountain Remote Sensing Cartography. – University of Karlstad Publications, Natural Sciences/ Technology, Research Report 97:3, Karlstad, Sweden, 263 pages.
- BUCHROITHNER, M.F. (Ed.), 1996: High-Mountain Remote Sensing Cartography. – Proceedings of an International Symposium on High-Mountain Remote Sensing Cartography, Kartographische Bausteine 12, Institute of Cartography, Dresden University of Technology, 144 pages.
- BUCHROITHNER, M.F., and KOSTKA, R. (Eds.), 1988: Remote Sensing: Towards Operational Cartographic Application. – Proceedings of the Willi Nordberg Symposium 1987, Forschungsgesellschaft Joanneum, Graz, Austria, 314 pages.

KOSTKA, R., and BUCHROITHNER, M.F., 1994: High Mountain Remote Sensing Cartography; the TADAT Research Project in the International Tauern Dachstein Testsite. – Final Report – Executive Summary of the FWF Project P 8048 GEO, Graz University of Technology, Graz, Austria, 13 pages.

LEGUIZAMÓN, S. (Ed.), 1995: Proceedings of the 3rd. International Symposium on High-Mountain Remote Sensing Cartography. – Instituto de Investigaciones Aplicadas de Ciencias Espaciales (IIACE), CONAE & CONICET, Mendoza, Argentina, 222 pages.

LIU, JIYUAN and BUCHROITHNER, M.F. (Eds.), 1993: Proceedings of the Second International Symposium on High Mountain Remote Sensing Cartography. – Astronautic Publishing House, Beijing, P.R. China, 263 pages.

Satellite image maps of high mountain areas presented at symposia of HMRSC:

At HMRSC I, 1990: Annapurna Satellite Image Trekking Map, 1:250,000, 1 sheet, Landsat-MSS images, CARTOCONSULT Austria, Graz, Austria.

At HMRSC II, 1992: Landsat Image Map of China, 1:4,000,000, 2 sheets, Landsat-MSS images, Institute of Remote Sensing Applications, Chinese Academy of Sciences, Beijing, P.R. China.

At HMRSC III, 1994: Mc Murdo Dry Valleys, Antarctica, Satellite Image Map, 1:100,000, 1 sheet, Landsat-TM image, U.S. Geological Survey, Reston, Virginia, USA.
Mendoza-Aconcagua Satellite Image Map, 1:100,000, 1 sheet, Landsat-TM image, U.S. Geological Survey, Reston, Virginia, USA, in cooperation with the Institute of Applied Research for Space Sciences (IIACE), Mendoza, Argentina.

At HMRSC V, 1998: N.W. Frontier Pakistan Satellite Image Map, 1:500,000, 1 sheet of 7, Landsat-MSS images, U.S. Geological Survey, Denver, Colorado, USA.
Northern Area Pakistan Satellite Image Map, 1:500,000, 1 sheet of 7, Landsat-MSS images, U.S. Geological Survey, Denver, Colorado, USA.