B. *Implementing the equity provisions of the Biodiversity Convention*

Industrialized nations should contribute *0.01% additional ODA* for the purpose of being credited to a Global Fund for Biodiversity for Sustainable Food Security. Such a fund can be handled as a trust fund under the Global Environment Facility (GEF) for implementing the Global Plan of Action adopted at the International Technical Conference on Plant Genetic Resources held at Leipzig in June, 1996, and for recognizing and rewarding the contributions of indigenous and rural women and men to the conservation and enhancement of biodiversity, that is, Farmers' Rights. It should also be used to safeguard all mega-biodiversity areas as well as 'hot-spot' locations with reference to threats to biodiversity, ranging from landscapes to individual species. In addition, for this purpose developing nations rich in agrobiodiversity should levy a 1% cess on all agricultural produce for being credited to a National Community Gene Fund to be used to recognize and reward the contributions of tribal and rural families to the *in-situ* conservation and enhancement of agro-biodiversity. Such steps will help to restore and revitalize the on-farm genetic conservation and selection-traditions of rural communities.

The role of the international community

To maximize efficiency and return on investment in the Evergreen Revolution, south–south partnership and cooperation in research and development will be essential, especially among nations with related agroecologies. The CGIAR centres should support these emerging regional networks and national systems, pursuing a policy of subcontracting present responsibilities as appropriate. We, the Summit participants, resolve to establish an *International Scientific Steering Committee for Sustainable Food and Nutrition Security,* to provide political leaders with the scientific framework necessary to achieve food for all. Broader consensus can be fostered through a *Global Coalition for Sustainable Food Security* including farmers' organizations, civil society, academia, corporate sector, service organizations and mass media.

To convert the rhetoric of 'food for all' into reality within a specified time frame, we urge the G-7 and G-15 countries to jointly establish a high level *Steering Committee for Sustainable Food and Nutrition Security,* for which FAO could provide the Secretariat. This unique political body would be fundamental in reaching the shared goals of global food and environmental security, reduced need for emergency aid, enhanced political stability and the development of new markets for trade. This is a responsibility which the political leaders of the G-7 and G-15 countries must accept at the November, 1996, World Food Summit, if we are to enter the new millennium with hopes for a new humane world.

The 11th Himalaya–Karakoram–Tibet Workshop: Conference report

The Himalaya–Karakoram–Tibet (H–K–T) Workshops, held annually since 1985, are a timely response to the growing interest among the international geological community in the Himalaya-Tibetan region (see Sorkhabi[1] for a report on the 10th H–K–T Workshop in Switzerland). These annual meetings are part of an international 'boom', which has made the Himalaya-Tibetan region probably the most prolific field of geologic research among the mountainous terrains of the world. The recent boom in the Himalaya-Tibetan geology is a continual part of more than 150 years of geoscientific research in the Himalaya and south Asia. However, the present diversity and extent of international involvement in the Himalaya-Tibetan geology is unprecedented. The aim of this Himalaya–Tibet saga is no less than unravelling the 'biggest tectonic puzzle of Cenozoic Earth'.

Unlike Britain and continental Europe, whose tradition of geological research in the Himalaya dates back to the first half of the 19th century, North America is relatively a newcomer to the scene. The first and the only American to have lived and worked in the Himalaya during the 19th century was Alexander Gardiner (1785–1877). Gardiner worked as an army officer in the forces of several kings in Kashmir. His wanderings and missions took him to all of the mountain ranges of the western Himalaya and the Pamir before any European explorer knew of these places. However, Gardiner did not document his observations and travels as a contribution to geographic knowledge[2].

The 1930s may be regarded as the 'initial pulse' of American studies in the Himalayan region. Helmut de Terra, a German geologist who had immigrated to the US and joined the Carnegie Institution of Washington, carried out pioneering research on the Quaternary geology of the west Himalayan foothills. In the same decade, G. Edwards Lewis and Paul D. Krynine at Yale University began research on the Siwalik formations; the Yale tradition in Siwalik studies (such as the palaeontological work of David Pilbeam) continued through the 1980s. Also in the 1930s, Edwin Colbert examined the Siwalik vertebrate fossil collection at the American Museum of Natural History in New York.

The 'plate tectonic revolution' of the 1960s motivated tectonic studies of the Himalaya and Tibet as this region came to be regarded as a 'type example' of continent–continent collisional orogenesis. Initially these studies were of 'armchair geophysics' genre, using seismic data and tectonic modelling. Over the past two decades, several institutions in the US have carried out field-based studies in the Himalaya and Tibet, resulting in an increasing number of graduate dissertations. Some of these active groups are those at Dartmouth College (where the late Noye Johnson with his students and colleagues carried out intensive research on the Siwalik Group of Pakistan), Orogen State University, Cornell University, Massachusetts Institute of Technology, University of California and University of Southern California (both at Los Angeles), etc. In addition, there are many individual Himalayan researchers scattered throughout North America. In recent years, numerous sessions and symposia devoted to the Himalaya and Asia have been held at the annual meetings of American Geophysical Union and Geological Society of America. The US National Science Foundation has also funded numerous research projects on the Himalaya.

The 11th H–K–T Workshop, held at the Du Bois Center of the Northern Arizona University in Flagstaff (Arizona) from April 28 to May 2, 1996, was the first H–K–T Workshop in North America. It was a logical outcome of the increasing involvement of American geoscientists in the Himalaya-Tibetan region. Organized by Allison Macfarlane (George Mason University), Rasoul Sorkhabi (Arizona State University), and Jay Quade (University of Arizona), the Arizona workshop was attended by a total of 115 persons from various countries. Figure 1 shows the geographic distribution of the participants.

Before the workshop began, a one-day field excursion was made to the Grand Canyon on April 28; it was guided by Troy Péwé and Edmund Stump of Arizona State University. After the workshop, another field excursion was made from Flagstaff to Phoenix on May 2. Guided by Stephen Reynolds of Arizona State University, this field excursion was meant to show some geological features of the Basin-and-Range province of Arizona. Each of the field excursions was attended by about 50 people.

The three-day workshop covered various aspects of geological sciences of the Himalayan mountains and the Tibetan Plateau. The morning sessions were devoted to special topics.

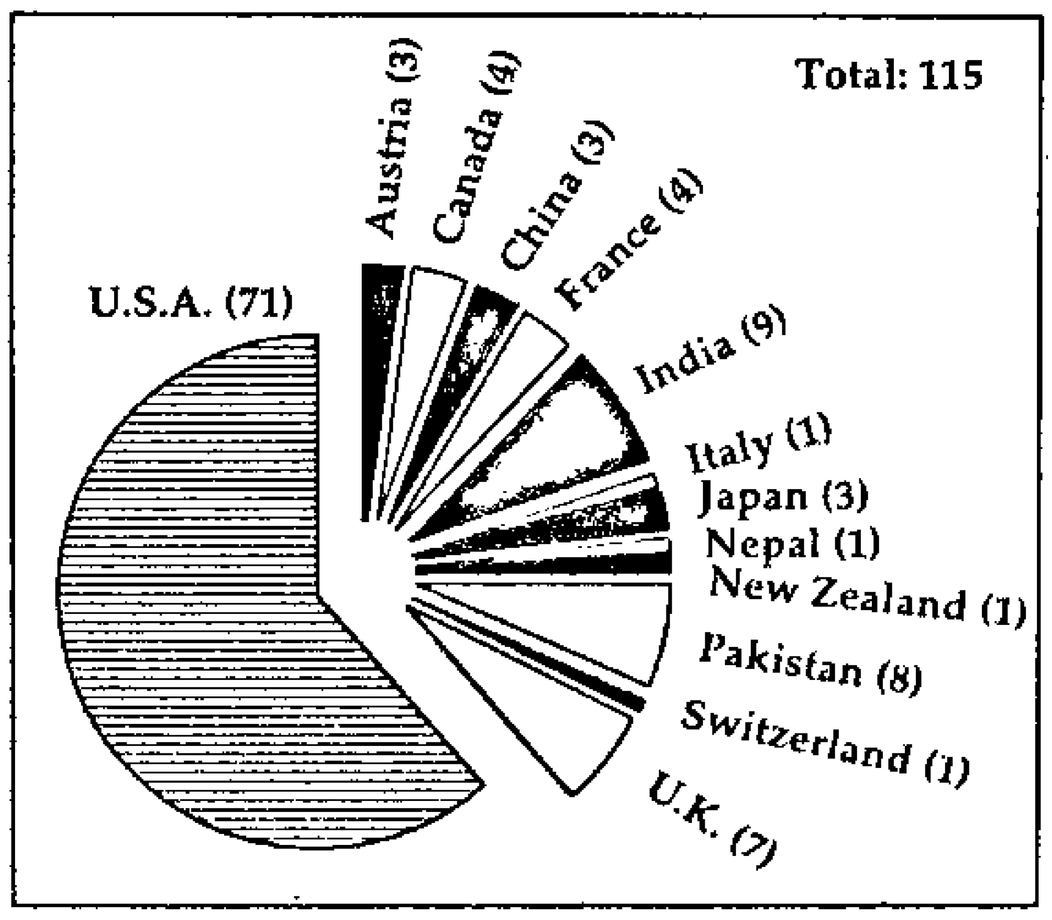

Figure 1. Geographic distribution of the participants at the 11th Himalaya–Karakoram–Tibet Workshop, USA.

The first special session (on 29 April) was on 'Geodynamic models of the Himalaya and Tibet'. From a geological point of view, the Himalaya–Tibetan region is a massive stress system on earth brought about by the head-on collision of the Indian continental plate with Asia during Cenozoic times. While the plate tectonic framework is generally accepted, details of the tectonic evolution and geological processes shaping the Himalaya and Tibet are far from clear. Since India collided with Asia 55 ± 10 million years ago, India has penetrated into Asia for about 3000 metres[3]. Some of the intriguing questions concern this 'missing continental crust': Was the crust simply shortened by folding and thrusting, and this deformation distributed throughout the Himalaya as well as the entire Tibet? Has the Indochina block (in southeast Asia) extruded southeastward out of the way of an Indian indenter, and thus opened space for the northward motion of India? Has the Indian crust subducted beneath the Tibetan Plateau, thus forming a double-normal thick continental crust? Or has a combination of all these processes taken place? If so, how to quantify their relative dominance in space and through time? Closely linked with the problem of the 'missing continental crust', there is another set of questions concerning the 'uplift of the Roof of the World', which the Himalaya-Tibetan region represents: How and when did the Himalaya and Tibet uplift? What is the nature of lithosphere–asthenosphere interactions beneath Tibet? Is a hot spot trapped beneath Tibet, thus deriving its thermal uplift as well as crustal extension? In attempts to answer these questions, several tectonic models have been proposed. Speakers in the first special session explored some of these models, and presented new data and ideas. Compared to the 1960s, when plate tectonics was emerging, great progress has been made in obtaining geophysical, geochemical, and geochronological and other quantitative data. Some of the exciting results come from deep seismic crustal profiles of southern Tibet carried out by a US–Chinese collaborative project called INDEPTH (International Deep Profiling of Tibet and the Himalaya)[4]. However, to work out definite, detailed geological scenarios of the Himalaya and Tibet, the ratio of speculation/fact is still high, and we need more data from various sectors of this vast, less accessible region.

The Himalayan region is sometimes described by geologists as a 'natural laboratory'. They are mountains in the making by vigorous tectonic forces and in the shaping by powerful denudation agents. This provides a common ground for geoscientists in the fields of Quaternary geology, neotectonics and geomorphology to investigate the interactions of tectonic and geomorphic processes in the Himalaya. The second special session (on April 30) focused on the 'Neotectonic and Quaternary geology of the Himalaya and Tibet'. Topics covered in this session included: Applications of global positioning system to quantify the ongoing convergence between India and Asia[5]; determining the recent uplift rates of the Himalaya both from geophysical modelling and direct geodetic measurements; seismic activity (both palaeoseismicity and monitoring of current earthquakes); geomorphic analysis of mountain terrains by space-based imagery techniques; understanding the role of tectonic activities in the geomorphic development of river systems; determining exposure rates of rocks by cosmogenic nuclides; mass wasting and mountain slope processes; mapping and monitoring the dynamics of glaciers; studies of loess; late Cenozoic glaciation record in the Himalaya and Tibet. These topics are not purely scientific; they have important implications for development, construction projects, landuse, hazard mapping, and resource management in the Himalaya and Tibet.

Although the Himalaya–Tibetan region is fundamentally the product of a compressional (crustal shortening) tectonic regime, it has long been known that there are east-west extending grabens in Tibet, suggesting the gravitational collapse of the plateau. Over the past decade, discovery of a basement-cover detachment – the so-called South Tibetan Detachment[6] – in the Himalaya has drawn a widespread interest among geologists. The South Tibetan Detachment essentially separates the Paleozoic sedimentary sequence of the Tethys Himalaya (on its hanging wall to the north) from the high grade metamorphic and granitic rocks of the Higher Himalaya (on its footwall to the south). More detailed studies have also mapped extensional structures in other geological zones of the Himalaya; for example, S–C fabrics in the Higher Himalayan metamorphic zone, and normal faults in the foothills of the Himalaya. Interestingly, unlike the east-west spreading grabens of Tibet, the Himalayan extensional structures are parallel to the general east-west strike of the mountains, demonstrating that compression and extension have occurred in the same north–south direction. Available geochronological data also indicate that these two events may be temporally linked to each other. The existence of these two contrasting tectonic regimes in a single orogenic system (which is also, geologically speaking, quite young and still active) provides crucial clues to understanding how tectonic processes deform rocks and develop highlands on the earth as well as put physical caps on their development. Kip Hodges of Massachusetts Institute of Technology remarked that it is no wonder that the highest fault on earth (on top of Mount Everest) is a normal fault. The third special session (on May 1) discussed Himalaya-Tibetan examples of 'Extensional tectonics in a compressional orogenic system'. This area of Himalayan research is expected to attract more attention in the coming years. Especially important will be close examinations of (i) absolute time relations between the activity of the South Tibetan Detachment marking the northern boundary of the Higher Himalayan metamorphic zone and the Main Central Thrust marking its southern boundary; (ii) the relations of Himalayan granites produced by crustal anatexis during the Tertiary both to compressional (hence crustal thickening) tectonics and extensional (hence decompressional melting) tectonics; and (iii) similarities and variations in tectonic style and timing of extensional faults along the strike of the Himalaya.

The afternoon sessions of the workshop covered regional topics. On April 29, two parallel sessions were held on 'Western Himalaya/Karakoram' and 'Sub-Himalaya (Foreland Sediments)'. On April 30, 'The Main Central Thrust Zone' as well as the Poster Session were covered. Finally on May 1, two other parallel sessions were held on 'The Higher Himalayan Crystalline Terrain' and 'Tibet and Trans-Himalaya'. Holding parallel sessions usually has the downside of splitting participants, which may not be welcome by the participants wishing to hear all the lectures. Nevertheless, it was not possible time-wise for the organizers to fit all of the presentations in single sessions in a three-day workshop. Especially considering the view that in workshops (unlike conferences) more time should be given for questions and discussion. Indeed a novel aspect of the 11th H–K–T Workshop (differing from the usual 15-minute conference presentations) was that each oral presentation was 20 minutes long; furthermore, an open discussion (coordinated by two leaders) for one hour was held at the end of each session. This allowed for more questions, comments, and debates on the topics covered in each session.

A total of 101 presentations were made at the workshop: 71 oral and 30 posters. Geographic distribution of the presentations is shown in Figure 2. It can be seen that 49% of the presentations were on the western Himalaya (Pakistan and India), and that relatively much less research is conducted on the eastern parts of the Himalaya and on the Karakoram–Pamir–Hindu Kush mountains.

It is also informative to consider the distribution of the presentations in terms of the geological divisions of the Himalaya. The Himalaya is divided into five longitudinal zones, separated from each other by major faults[7]. These zones are as follows from north to south: (i) the Trans-Himalaya and the Indus-Tsangpo Suture Zone (the initial plate boundary between India and Asia); (ii) the Tethys (or Tibetan) Himalaya; (iii) the Higher (Greater) Himalaya; (iv) the Lesser (Lower) Himalaya; and (v) the Sub-Himalaya (Outer Himalaya or the Siwalik hills). Figure 3 shows the distribution of the presentations at the workshop according to geological divisions. 33% of the papers were on the Higher Himalayan metamorphic and granitic rocks (i.e. 'hard rocks') towards understanding such processes as metamorphism, crustal anatexis and emplacement of granites, processes of uplift and denudation of deep-seated rocks, timing of major faults and tectonic events in the Higher Himalaya. If the submitted abstracts is taken as a rough measure of research done in the Himalaya (this is a big IF, but the same inference can also be made from considering the subject-matter of Himalayan papers published in general geology journals), it is inferred that relatively less research is conducted in the Tethys Himalaya and the Lesser Himalaya. This is unfortunate because these two sedimentary zones provide valuable information on the Proterozoic, Paleozoic and Mesozoic events.

Only one paper on palaeontology (on the trilobites of the Zanskar region) was presented at the workshop. Much more research in Himalayan stratigraphy and palaeontology is required. The Tethys Himalaya has exposed marine sedimentary formations spanning in stratigraphic time from the trilobites of Cambrian seas until the Great Dying of Cretaceous ammonites. There are also Cenozoic sedimentary formations and fossils in the Himalaya, especially the mammalian fossils in the Siwalik Group, which provide valuable opportunities for examining the evolution of life and environment in the geological past.

Similarly more attention needs to be paid to the Lesser Himalaya. A major problem with this zone has traditionally been the lack of fossils to work out its stratigraphy and relative displacement of rock formations. Perhaps, this is a wrong expectation any more. Applications of high-resolution geochronological and geochemical techniques in conjunction with detailed field mapping in the Lesser Himalaya provide important clues to un-

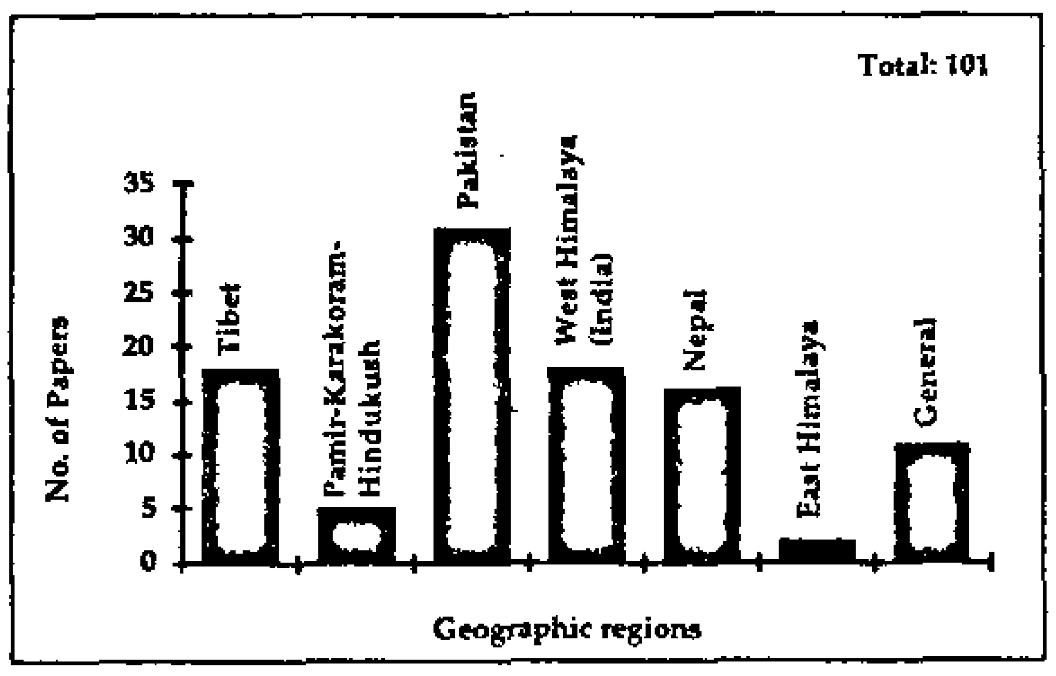

Figure 2. Presentations (both oral and poster) at the 11th Himalaya–Karakoram–Tibet Workshop according to geographic regions of research (Tibet is here considered as a geopolitical region).

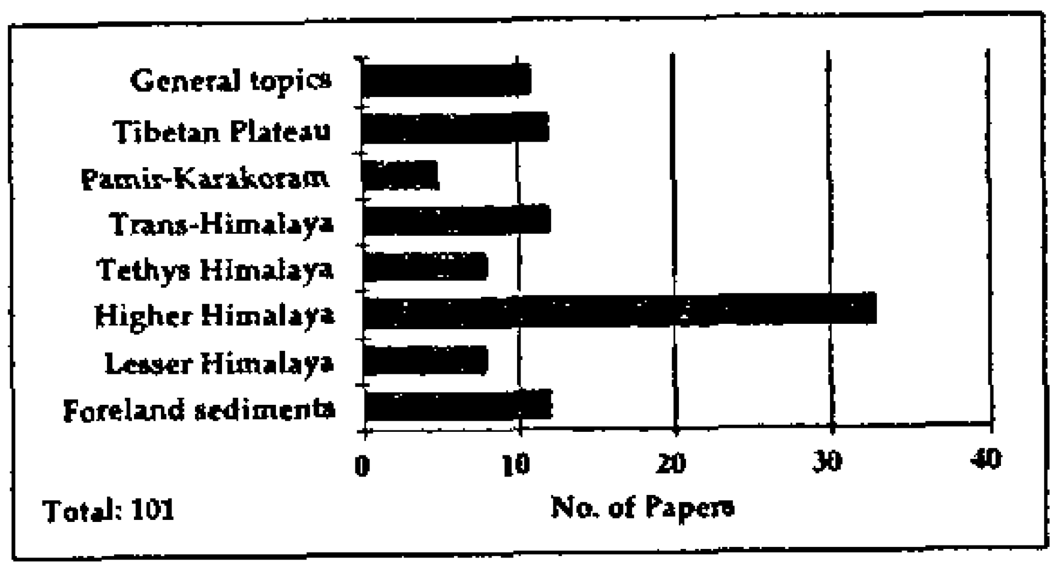

Figure 3. Presentations (both oral and poster) at the 11th Himalaya–Karakoram–Tibet Workshop according to the geological divisions (Tibetan Plateau is here considered as a geological zone to the north of Trans-Himalaya).

derstanding the Precambrian history of the earth. Moreover, the Lesser Himalaya is the most populous zone of the Himalaya, containing forests, agricultural lands, human settlements, infrastructures, etc. Research in such fields as geomorphology and neotectonics of the Lesser Himalaya would be important in terms of understanding the mountain–human interactions.

Selected, refereed papers resulting from the workshop will be edited by the organizers and published as a volume of the *Geological Society of America Special Paper*, and also possibly in a special volume of the journal *Tectonophysics*. Financial support for the Workshop came partly from registration fees and partly from a grant from the Continental Dynamics Program of the US National Science Foundation (NSF). The NSF grant mainly supported travel funds (some partial support and some full funds) for 24 researchers from the Himalayan countries (China, India, Nepal, and Pakistan) and students from Europe. The Indian participants at the workshop were from the Wadia Institute of Himalayan Geology (Dehra Dun) and University of Roorkee. Overall, 28 of the participants were originally from the Himalayan countries (including those residing in the US or Europe). Indeed, one of the successes of the workshop was that it could provide financial support for native researchers in the Himalaya to attend this international meeting. (Nearly 100 applications were received for travel award; it was not financially possible for the committee on travel awards to respond positively to all of these requests.) Participation of researchers from the Himalayan countries is important for the H–K–T Workshops; however, not all organizers have been or will be able to obtain the necessary funds (especially in view of shrinking government budget for science in recent years). One solution is to hold the H–K–T Workshops frequently in the Himalayan countries (so far, only one of the workshops has been held in the Himalayan region, namely the Kathmandu Workshop in 1994). This solution was suggested in Flagstaff during the planning session for the 1997 H–K–T Workshop, and deserves more attention.

The 12th H–K–T Workshop will be held in Rome (Italy) in April 1997 on the occasion of the 100th anniversary of birth of Ardito Desio, a geologist who carried out pioneering research in the Karakoram mountains.

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Chaos – A new paradigm for comprehending nature

The earliest study of what is today known as *deterministic chaos* dates back to the paper entitled 'Deterministic Nonperiodic Flow' by E. N. Lorenz[1] in 1963. However the concepts of chaos took roots only in the seventies. By the eighties there was an exponential growth in the numbers of research articles and books. Journals devoted entirely to this dynamic new concept were started, and the number keeps increasing – especially if one considers the related areas of fractals and complexity.

A four-day Workshop on Complex Systems (chaos) was organized under the auspices of CSIR Technical Advisory Board (Physical, Environmental & Earth Sciences), hosted by C-MMACS, at C-MMACS/NAL from June 26 to 29, 1996. The motivation for holding this Workshop stemmed from the view that it would be desirable to empower CSIR scientists with a working knowledge and hands-on experience in this fascinating, new, dynamic area of physics so that they may make creative applications of these paradigms to new problems in their respective fields. Interested scientists and students from outside CSIR were also included among the participants to ensure benefits on a wider scale. The participants had a background in diverse areas of physics, biology, engineering, mathematics, computer science, etc.

Deterministic chaos is a nonlinear phenomenon and is easily understood by studying the behaviour of the simple one-dimensional nonlinear map[2], the so-called logistic map, $x_{n+1} = \mu x_n(1 - x_n)$. This is so simple that one can programme it on a hand-held calculator without much trouble. A physical understanding of this equation can be gained by considering the variable x_n to represent the normalized population of some organism in the nth generation, x_{n+1} becoming the population in the next generation. The model is discrete in time and assumes that the size of the present population depends only on the size in the previous generation (some insect species do approximate such simple dynamics). The first factor on the right hand side, μx_n, is the growth term and would lead to a runaway exponential increase but for the inclusion of the second factor. The latter, μx_n^2, represents the decay term and the limit to growth such as, for example, controlled by a finite amount of food supply. Here, we treat x_n as a normalized variable (a proportion of some maximal population) and consider values $0 < x_n < 1$. The model exhibits a range of dynamical behaviours for different values of the parameter, μ. Figure 1 shows a sequence of values of x_n, with $n = 1, 2, 3, \ldots$, namely an orbit of the system, for $\mu = 4$, and a similar behaviour is obtained regardless of any specific initial condition x_0. There is no regularity in the sequence: it looks quite random in character and is, in fact, quite unpredictable. The unpredictability is evident when one starts off with two initial conditions which are very slightly different from each other. After just a few iterations, the two sequences bear no resemblance whatsoever, and can differ from each other by arbitrary amounts within