Introduction

The Director's report for 2003 is a compilation of the individual annual reports prepared by the ISC staff. The reports were edited and compiled by A. Shapira who was appointed as Director of the ISC in January 2004.

During the year 2003, the ISC staff included:
Mr. Raymond Willemann (Ph.D.) – Director
Mrs. Maureen Aspinwall – Administration and Finance Officer
Ms. Maiclaire Bolton (M.Sc.) – Seismologist
Mr. Peter Dawson (Ph.D.) –Data Collection Manager and Applications Developer
Ms. Katherine Evans – Oxford Univ. student – summer project
Mr. Mathew Evans (M.Sc.) – Ph.D. student (Leeds University associate)
Mr. James Harris – Systems and Data Base Administrator
Mr. Richard Luckett (Ph.D.) – Seismologist and Applications Developer
Mrs. Nurcan M. Ozel (Ph.D.) – Seismologist
Mr. Dmitry Storchak (Ph.D.) – Senior Seismologist
Mr. Robin Adams (Ph.D.) – Honorary seismologist

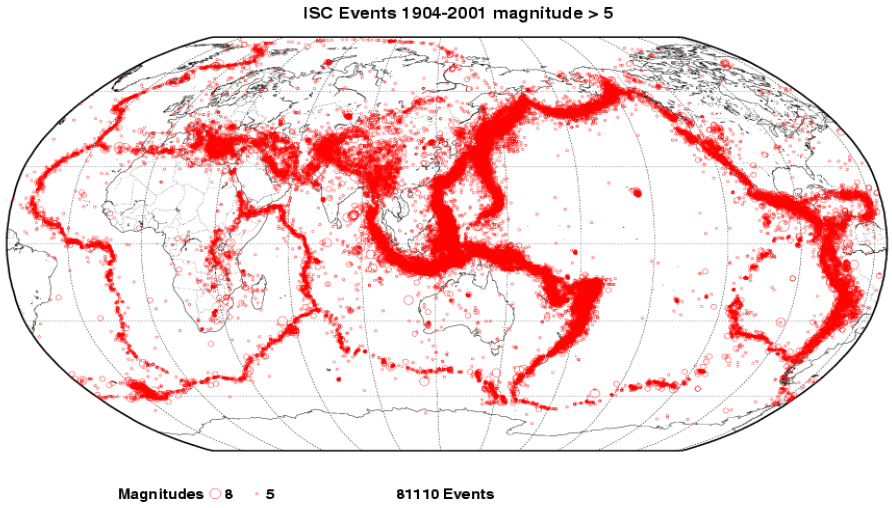
Introduction

The year 2003 was again a period of significant improvements and new developments in the main fields of operation of the ISC namely; seismological data collection, analysis and editing, data archiving and publication of seismological bulletins. New developments were made in parallel to maintaining the old software, the latter still requiring many man-hour resources.

During 2003, the ISC has published 6 printed issues of the bi-monthly seismological *Bulletin* for the year 2001, an annual seismological *Bulletin* for 2001 and an updated earthquake *Catalogue* for 1904-2001 on CD (see seismicity map in Fig. 1).

One of the major contributions to the operation of the ISC was the continuous development of the analysis software ISCloc. This operation and others are described in the following sections of this report.

Fig. 1: World Seismicity 1904-2001 (M>5)



Data Collection

During 2003, normal operational aspects were carried out i.e., daily monitoring of the automated e-mail data acquisition system and dealing with unknown stations, data entry mistakes, changing of e-mail formats etc. The work involves the maintenance and updating of existing parsers and the writing of new parsers. Also, extensive correspondence is required with station operators and data providers.

In comparison to the year 2002, the following agencies/institutions started or renewed their data contribution to the ISC:

DDA – Earthquake Research Dept., General Directorate of Disaster Affairs, Turkey
HRVD_LR - Harvard University, USA
IAG - Universitario de la Cartuja, Spain
KNET – The seismic network of Kyrgyzstan
LIC - Ivory Coast
NIED - National Research Institute for Earth Science and Disaster Prevention, Japan
NSSC - National Syrian Seismological Center, Syria
SPA - USGS seismic network in Antarctica
SSNC - Servicio Sismologico Nacional de Cuba, Cuba
TRI – University of Trieste, Italy
UAV - Red Sismologica de Los Andes Venezolanos, Venezuela
All agencies who sent data to ISC in 2002 continued in 2003. Stations reporting data to the ISC during 2003 are depicted on the map in Fig. 2.

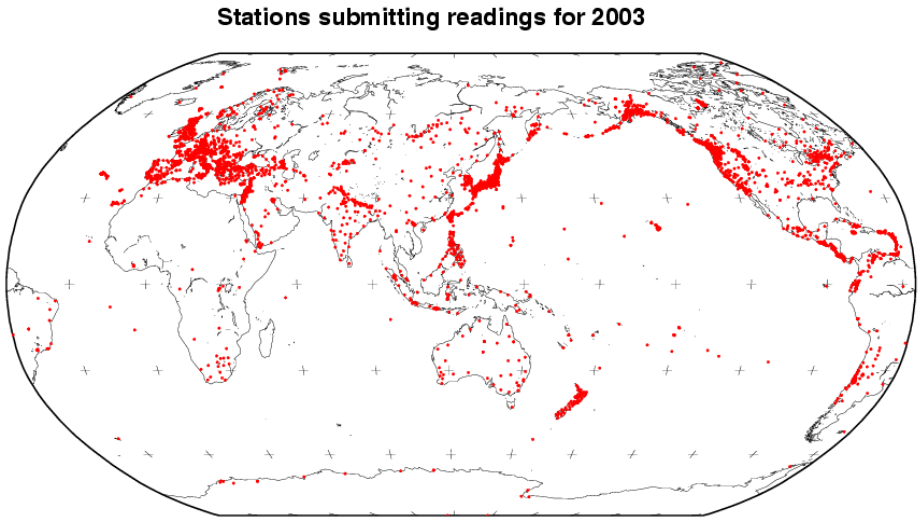


Fig. 2: Distribution of seismic stations that contributed phase readings to ISC during 2003.

Bulletin Editing

During 2003 the ISC seismologists reviewed the data for the 12 month period starting with March 2001. All events with maximum reported magnitude of 3.5 and larger, along with events with multiple network reports or station reports at distances greater than 10 degrees were analysed and where possible, relocated. Several large earthquake sequences were processed: near the coast of Peru in June-July 2001, Aegean Sea in July-August 2001, east of the North Island of New Zealand in August-September 2001, off the east coast of Kamchatka in October 2001, Taiwan region in December 2001 and Vanuatu Island region in January 2002.

As usual, the major difficulty was to ensure a proper grouping of local hypocentral solutions with those based solely on teleseismic data. As shown in Fig. 3, the earthquake catalogue for the period analysed during 2003 is complete for earthquakes of magnitudes greater than 3.8. All events of magnitudes 4 and above have been reviewed and most of them could be relocated by ISC by integrating data from a number of reporting agencies.

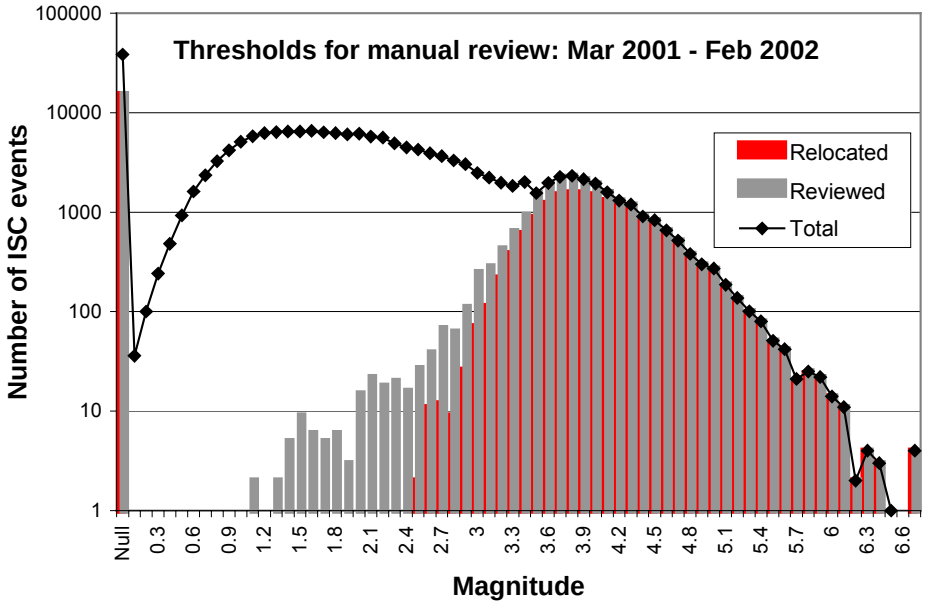


Fig. 3: Number of events in the ISC Bulletin for the period March 2001 to February 2002 (Total, Reviewed and Relocated) as a function of the reported magnitude

Figure 4 presents the pace at which monthly seismological bulletins have been compiled. To eliminate the backlog in manual analysis, a new seismologist was recruited earlier than originally planned to allow a wider overlap time with existing seismologists. Maiclaire Bolton from the Geological Survey of Canada was hired in November 2003 straight after finishing her Masters degree at University of Victoria. As expected, training a new recruit slowed the routine reviewing process and resulted in the process reverting to the standard schedule, when events are published two years behind real time. When the training phase is complete, we expect to reduce the review delay and progress towards the accelerated schedule shown in Figure 4.

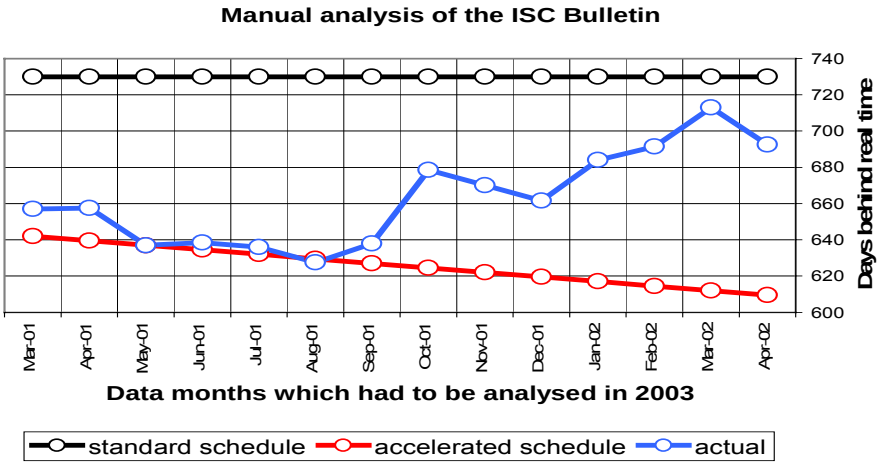


Fig. 4: Planned and actual completion of the monthly reviewed bulletins in 2003

FTP Service

An anonymous FTP server, ftp://ftp.isc.ac.uk, was set up to allow prompt distribution of the results of the ISC's monthly analysis. These files are available very shortly after the completion on each month's editing and allow access to the results much more rapidly than the once yearly CD.

The files on the server parallel to those on ISC CDs. *Catalogue* files (which have only hypocentral parameters) and *Bulletin* files (with both hypocentres and associated phase readings) are available, and each is posted both in 96-column format and IASPEI Seismic Format (ISF). These files are compressed, which can greatly speed downloads even with the server's fast Internet connection. Even so, users who do not require phase data will still find that retrieving the Catalogue files is quicker.

The typeset monthly *Bulletins* and the semi-annual *Regional Catalogues* are also available as PDF documents. Users who browse the listings may find these typeset documents easier to use, and they include the separate lists of explosions and major events that have long been included in the Catalogue.

During 2003 14,000 FFB/ISF and 300 PDF files were downloaded from the server by over 200 different people or agencies.

International Registry (IR) of Seismic Stations

The International Registry of Seismic Stations facilitates exchange of data between networks by identifying seismic stations anywhere in the world with a unique 3 to 5 character code. The Registry is maintained jointly by the ISC and by the World Data Center for Seismology, Denver, which is operated by US National Earthquake Information Center (NEIC). The ISC, NEIC and the European-Mediterranean Seismological Centre encourage registration of all stations, regardless of whether or not the data seems likely to be widely distributed. The Federation of Digital Seismograph Networks recognises identification of parametric data with station codes from the International Registry and network code 'IR'.

On the ISC website, the new form at http://www.isc.ac.uk/IR/reg.htm makes it convenient for network operators to add stations to the Registry. When a station operator submits the registration form, computer programs at the ISC compare the new information with previously registered stations. By immediately prompting users when information is incomplete and by suggesting alternative station codes in real time, the new system reduces the effort required of both station operators and Registry maintainers.

When the on-line form is used to register a station, the ISC promptly e-mails a registration record to both the operator and NEIC, and amends the ISC's copy of the Registry. Thus, the new code can be used in parametric data reports to both the ISC and NEIC as soon as the operator receives a registration record.

In the Registry, a code is used to identify the site of a seismic station, rather than a particular instrument. Thus the Registry does not deliberately include multiple codes for any site, regardless of how many different seismometers exist or have existed at the site. To maintain this aspect of the Registry's integrity, the on-line system will not register a new station that is very close to a

previously registered station. In rare cases when a genuinely new station is very close to a previously registered site, network operators can use the existing system of registering stations by exchanging e-mail with the ISC or the NEIC. To March 2004, 217 station codes have been registered through the online registry.

Station Book

An on-line station book has been developed as a new service for the International Registry of Seismic Stations at the ISC and can be accessed at http://www.isc.ac.uk/IR/ir.htm . Features of the station book include alphabetic listings of the Registry by station code, name or region and searches can be made for a code or for stations within 200 km of a specific point.

The station book was developed to be similar to the station book of the International Registry online at the NEIC, http://gldss7.cr.usgs.gov/neis/station_book/station_book.html.

The web-based station book is in addition to the existing distribution of an ASCII text file of the station book through the FTP site and on the ISC CDs.

It was expected that this would be an important addition to the ISC's web services and in the first 3 months over 200 hits on the main page and over 400 different listings have been requested, which is already 10 times the number of station lists downloaded via FTP in 2003.

ISC Database

ISC Oracle Database Performance Review

From the initial creation of the existing Oracle database in May 1999 the ISC's database has grown considerably in both size and complexity. The database is also subject to an ever increasing load from existing services, such as web searches (70000 in 2003) and data collection; a 17% increase in the database size during 2003 . The database size-increase in 2003 is principally due to an additional 10,000,000 associations (both ISC and reported), 6,000,000 phases and 750,000 hypocentres.

This makes the performance of many programs such as the automatic grouping and association difficult to maintain. It should be noted that, during 2004 new demands will be made on the database with the addition of the new location program (ISCloc) and the editing processes carried out by the ISC seismologists will become fully dependent on the database .

Many tools have been used and developed to monitor the database and a lot of modifications both to the database and to programs that use it have been carried out to keep performance levels high as load increases. As a part of this assessment an external review was carried out by CompelSolve, an Oracle Partner company. This concluded that the database was running efficiently but small improvements could be made. Many of these recommendations have now been carried out.

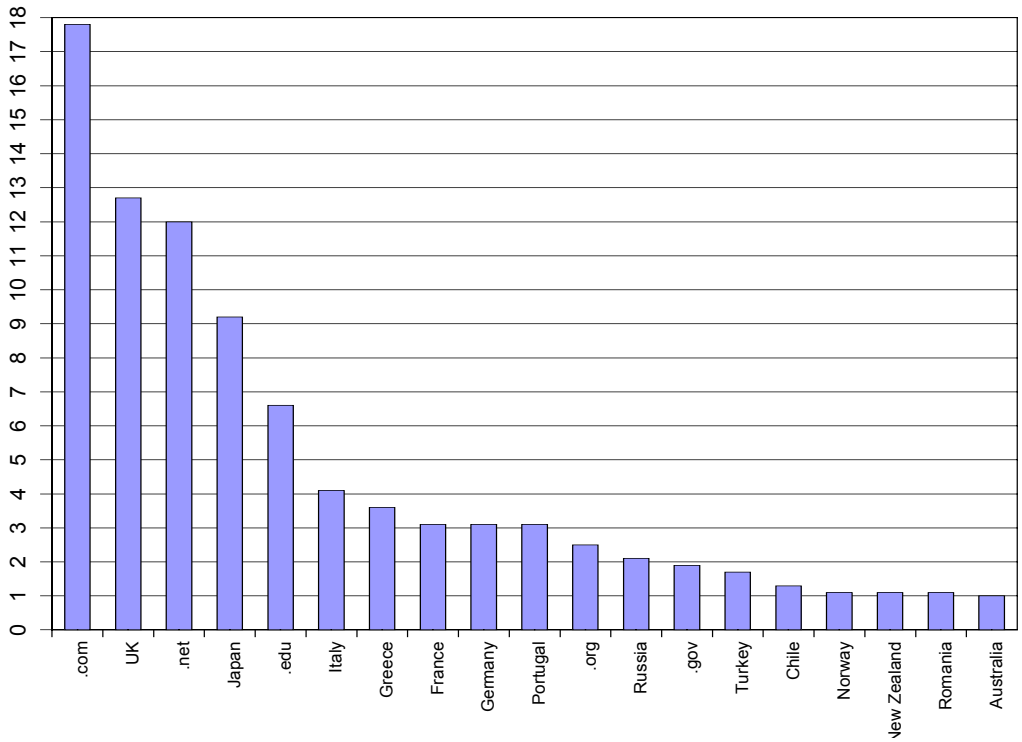
ISC Website

The ISC's website continues to see considerable use, with 800,000 hits in 2003, up 40% on the previous year. Of that total 70,000 Bulletin and 7000 bibliography searches were carried out, these being the two most popular individual pages.

The amount of data downloaded has also risen considerably with 26 Gb in total taken, of this 17 Gb were data from the Bulletin Search page. This is a massive increase on 2002 with 11 and 6 Gb respectively.

A breakdown of usage by country or domain is shown in Fig. 5. The chart only shows known results, for 40% of the hits on the website the domain could not be resolved. In most cases it can assumed that .com, .edu and .gov are all US sites giving a total of 26%.

Fig. 5: Distribution chart of entries to the ISC website



New features continue to be added to the website, the most significant being the FTP server, station book and station registration pages mentioned previously. More waveform retrieval links for data centres continue to be added to the on-line Bulletin.

In 2003, links were added to:

- The Consortium of Organizations for Strong-Motion Observation Systems, COSMOS
- The University of Granada
- Observatories and Research Facilities for European Seismology, ORFEUS
- National Research Institute for Earth Science and Disaster Prevention, NIED, Japan.

Computing Infrastructure

The only significant change during 2003 was the purchase of an inexpensive PC based Linux fileserver. The fileserver takes all of the non-database services previously on the main ISC server to help maintain the database performance.

Four small Uninterruptible Power Supplies (UPSs) were purchased for the three machines used by the ISC seismologists for editing and the Linux fileserver. These are intended only to prevent short outages losing vital work and to allow 5 minutes operating time for a controlled shutdown during longer outages. The Database server was already protected by a UPS.

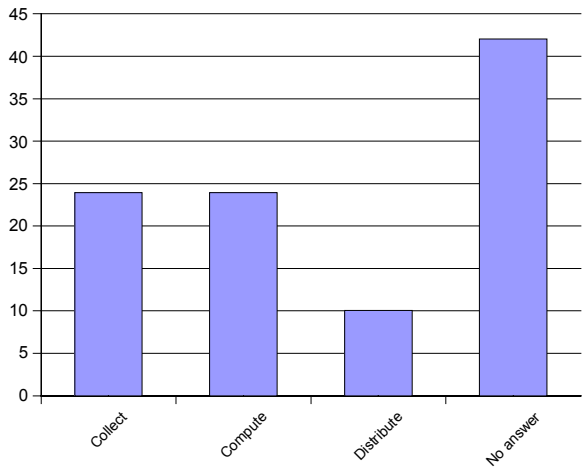
Survey Results (Updated from Jan-March 2003 Newsletter)

The ISC has been asking web users of its on-line Bulletin to complete a simple survey. So far, 784 users in 84 countries have responded.

Respondents are asked to choose the one thing that is most important for ISC to do, amongst - "collect more data", "compute better hypocentres", or "improve data distribution". Of the 443 who answered this question, the numbers favouring collecting more data and computing better hypocentres are identical at 42%. Only about 16% of all survey participants want the ISC to invest its efforts principally in improving distribution. Oddly the largest group of respondents, the US, favour collection (48%) over computing (31%).

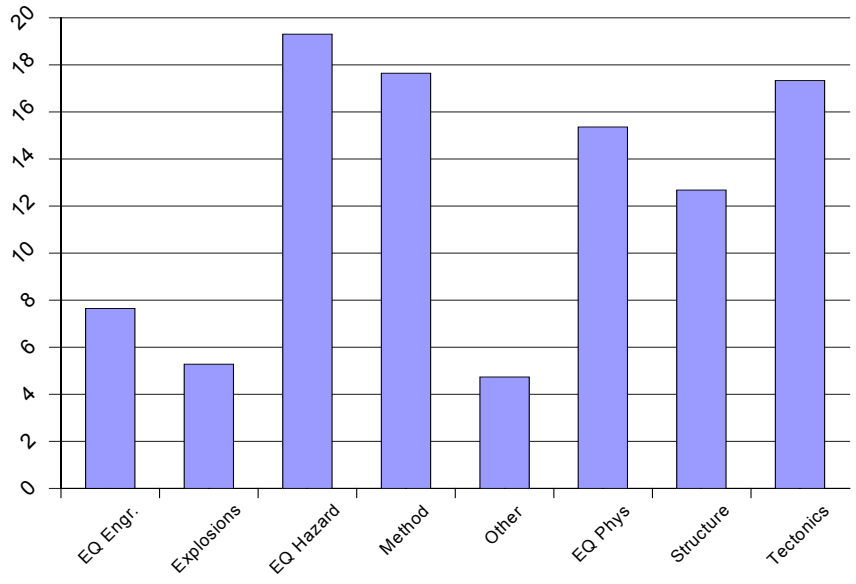
Among the 617 respondents who indicated what country they work in, the US (79) and Iran (44) are most well represented, followed by Greece, Russia, France, Canada, Romania and Japan.

Fig. 6: Preferences for the services of ISC



Respondents were also asked to indicate in which fields of seismology they worked (see distribution in Fig. 7). All fields placed distribution as the least favourite option. Among those working in "earth structure", "earthquake physics", "seismic hazard", "seismological methods" and any other field, no clear favourite between computing better hypocentres and collecting data was apparent. Those in "tectonics" favoured computing better hypocentres as the most popular area for improving the ISC. People whose field was "explosion monitoring" or "earthquake engineering" showed a clear preference for the improvements to be geared towards data collection.

Fig. 7. Distribution of responses to the ISC survey by field of seismological interest



Shear Wave Splitting of SKS Phases

In June 2002, the ISC undertook a collaborative project with the University of Leeds, to try and automate shear wave splitting measurements in SKS phases. As part of this work, software to automatically request and retrieve waveform data from a variety of external data centres needed to be written, which is now operational. Preliminary results from the splitting measurements were presented at the Fall AGU in San Francisco last year and a paper is currently being prepared for publication.

A prototype web interface for the distribution of results has been designed and is located at: http://www.isc.ac.uk/SKS.

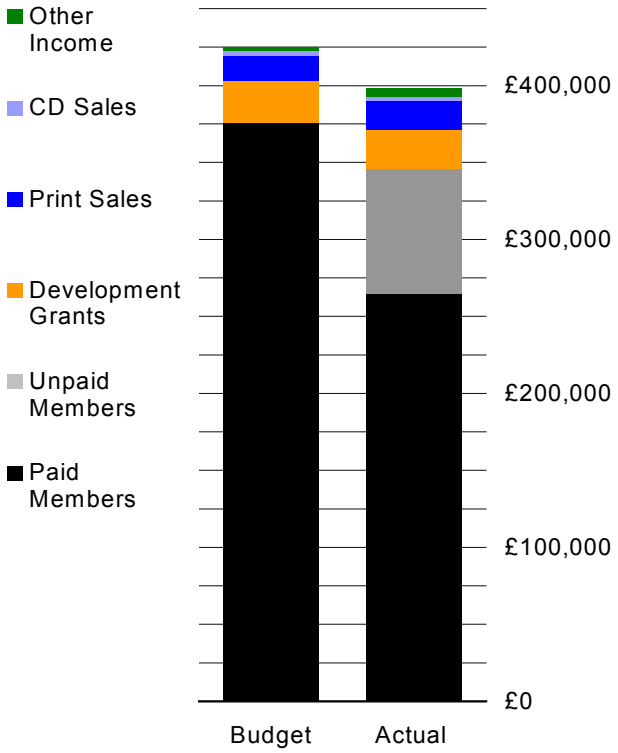
Production and Distribution

In 2003 the ISC distributed six bimonthly issues of the Bulletin averaging 202 pages per month. The Regional Catalogue has ceased publication on the advice of the ISC Governing Council. The time between despatching master copies and receiving products from the printer varied between 5 and 7 weeks. Print runs were held at 350. The Bulletin and Catalogue CDs were distributed within a few weeks of completing analysis for the year.

Product	Issue	Distributed
Bulletin	Jan/Feb	25 Feb
	Mar/Apr	14 Apr
	May/Jun	19 May
	Jul/Aug	8 Jul
	Sep/Oct	23 Oct
	Nov/Dec	17 Dec
	CD-ROM	12 Dec

Income

Member contributions (black and grey) fell short of expectations in the budget from last year's report. The difference arose because the rate for exchanging US Dollars to British Pounds fell significantly over the course of the year, from £1=$1.61 to £1 = $1.77. Member invoices are almost all in US Dollars and had a lower value when expressed in British Pounds at the end of year rate. In fact, expressed in British Pounds, actual contributions from institutional members fell 4.7% from 2002 to 2003 despite the increase in the unit rate of membership.



At year-end, some 25% of 2003 membership contribution invoices were unpaid (grey), but 93% of that amount arrived in January 2004 being caught in the Christmas post. The unpaid amount equalling just 9 units of subscription, approximately 3% of the total. The expected support for development consisted principally of a grant from the US National Science Foundation.

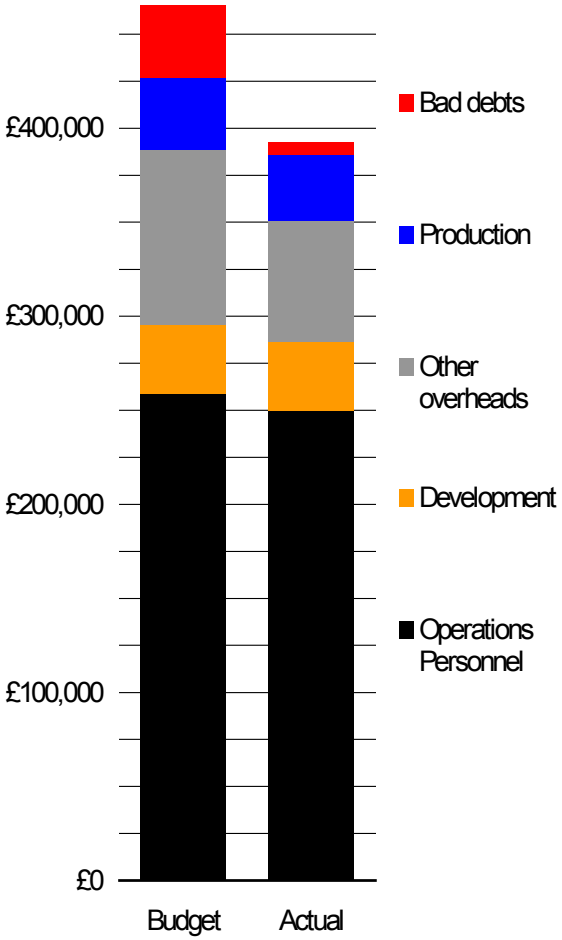
Income from printed products (dark blue) and CD sales (light blue) was close to the budget. The CD sales were just under budget and the printed products just over, although they were down on previous years since the Regional Catalogue of Earthquakes has ceased publication. Other income (green) consists of associate member contributions and sales of services. This income was more than expected as a special contract for NERC was performed by Richard Luckett.

Total income for the year fell short of expectations because the end of year exchange rate was most unfavourable for the ISC. The ISC receives much of its funding in US dollars but most of the expenditure is made in UK sterling.

Expenditure

Personnel expenditures (black and orange) are comprised of salaries, pension contributions, recruiting and repatriation expenses. These costs were 3.5% less than budgeted because the salary scales had not been agreed by UK academic unions and therefore increases for inflation were not activated. The ISC continues to follow UK academic salary scales as a guide.

Other overheads (grey) include costs for the ISC building, computing expenses, travel by the committee and staff, and costs of consumables. Expenses for the building were £8,000 less than budgeted thanks partly to a decrease in the interest rate and therefore on the value of the interest paid on the mortgage and partly to a saving on the cost of repair of the roof of the building. Committee travel was less than expected as was staff travel. One member of the Executive was unable to travel to Sapporo and everyone else managed to find reasonable airfares. Costs for staff travel, including participation by ISC seismologists in EGS and AGU annual meetings and the ESC bi-annual assembly, were in line with the budget. Costs for computing were over estimated but consumables were very close to the budget.

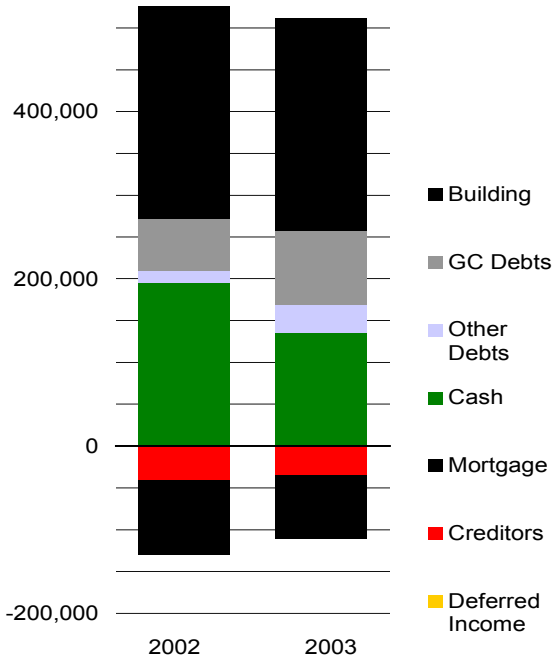


Production costs (blue) are to print and distribute the *Bulletin* of 2001 events, for which subscribers received invoices during 2003. These were £3,000 less than expected as savings were made in the distribution costs. The production costs were significantly less than in previous years as the *Regional Catalogue of Earthquakes* was no longer produced.

Costa Rica failed to pay their membership invoices for years 2001, 2002 and 2003 so in conformance to past practice when institutional members do not pay for 3 consecutive years, these invoices were written off as bad debts (red). Our original budget for 2003 had included a figure of $42,000 which was the amount that might have been lost if Russia had not been able to pay its subscription. Fortunately, funds from Russia arrived in 2003 to cover 2001, 2002 and 2003.

Assets

The net value of the ISC's liquid assets is the difference between cash and creditors, shown in green and red at the right. This includes bank balances required for the exchange rate and computer replacement funds. Net liquid assets decreased during 2003 from £154,000 to £100,000, reflecting amongst other things the late arrival of the USA (NSF) subscription, held up in the Christmas post. Liquid assets are the cash required to operate while not drawing on reserves. Apart from balances of the reserved funds, at year-end unencumbered liquid assets stood at £15,000, which is sufficient to continue operations for less than 1 month.



Current debts owed to ISC (grey and blue) are mostly unpaid membership invoices. At year-end, Argentina, Iran (AEOI), Ireland, Italy (CNR) and USA (NSF) (see above) owed the ISC for one year.

The net value of the ISC's current assets is the sum of its liquid assets and current debts owed to the ISC, which are shown in colours other than black. Net current assets declined during 2003 from £230,000 to £223,000. With these net current assets, the ISC could have continued operating without 2004 contributions for approximately six months if the Executive Committee authorised use of funds that are normally reserved.

The net value of ISC's tangible assets is the difference between the assets (above the "0" line) and liabilities (below the "0" line) shown in black. Net tangible assets increased from £164,000 to £178,000 due to a decline in the amount owed on the mortgage for the ISC's building. The ISC paid 4% of the original principal, as set out in the terms of the loan. In addition, because the loan is denominated in US Dollars, the amount owed expressed in UK Pounds fell with the exchange rate. The ISC plans to continue paying down the mortgage, leading to long-term growth of net tangible assets. But in the short-term net tangible assets may grow quickly, slowly, or even temporarily decline if exchange rates fluctuate.

The net value of ISC's total assets, which is the difference between all assets and liabilities, increased from £394,000 to £401,500 during 2001. This is well within British guidelines for charitable organisations, which suggest that net total assets should not normally be much more than twice the annual operating expenditures, or nearly £900,000 in the ISC's case.

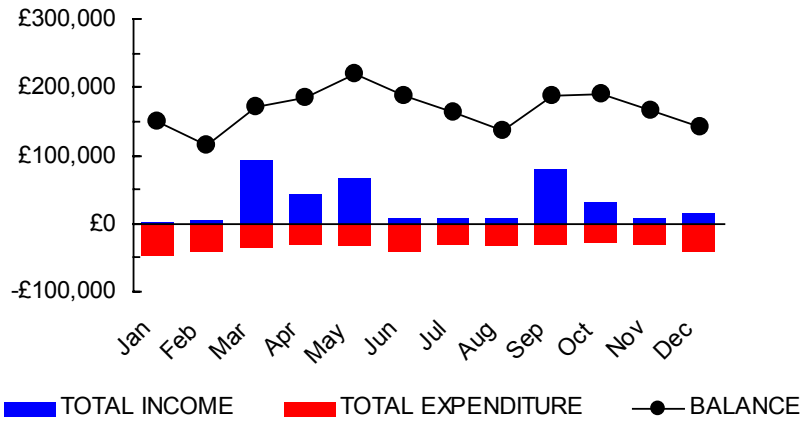
Excess Income and Reserves

The ISC recognises income from capital-purchase grants only when purchases are made, so that grant income and grant-funded capital expenditures are exactly offsetting. In conformance with international accounting standards, such grants and purchases are not shown as income or expenditures, and the value of such capital equipment is not shown as an asset.

During 2002, interest of £1,200 earned on one of the ISC's bank accounts was attributed directly to the computer replacement fund rather than being treated as income. As previously recommended by the Governing Council, the ISC transferred £5,000 from the general reserve to the computer replacement fund. Consequently, the increase of £7,239 in the general reserve is more than the surplus income of £5,972.

Cash Flow

The cash flow figure below shows receipts and outlays using dates when transactions were recorded at the bank, and bank balances with US Dollars converted to UK Pounds using the exchange rate as of 1 January 2003. Cash flow excludes credit extended to the ISC, debts owed to the ISC, and commitment of assets, such as the exchange rate and computer funds.



Receipts were large in March, April and May when the Royal Society and many other members contributed soon after receiving invoices and again in September and October when Russia paid the subscriptions for 2001, 2002 and 2003. Expenditure remained constant throughout the year.

The ISC maintains a £20,000 overdraft facility with the bank for emergency use if contributions are delayed and if other obligations need to be met then permission from the Governing Council chairman would be request to use the exchange rate or computer replacement funds kept in reserve.

Estimated Budget

The estimated budget for the years 2004, 2005 and 2006 is based on the following assumptions:

1. The annual subscription rates for members are at the rates agreed at the Governing Council meeting in Sapporo, 2003.
2. We assume a 3% annual inflation rate.
3. We expect in 2004 a significant drop in the cost of producing the publications. This saving will be made by producing a Bulletin without phase readings and only 3 issues per year. We have also arranged for the Bulletin to be produced in the UK since the savings that were originally made, almost 30 years ago, by using the printers in Thailand have been lost by less favourable exchange rates with the Thai Baht and the increasingly expensive freight costs.
4. Personnel costs allow for an annual increase of 5% out of which 3.44% are pay-rise that was due in August 2003 but not ratified until 2004. The rest are minimal promotions on the academic salary scale we used.
5. Building expenses include some minor refurbishments and general maintenance.
6. Travel costs for 2004 are reduced because the Executive Committee meeting is being held in Thatcham. We expect a significant increase in 2005 due to the IASPEI meeting being located in Chile.
7. Computing costs include the cost of a new printer this year and a new workstation in 2006 as well as everyday expenditure such as data line costs and consumables.
8. We assume that 3 agencies will stop their subscription to the ISC.
9. The National Contributions are calculated at the exchange rate at the time of writing this document, which was £1 = $1.81. The amount raised apparently falls because of this, despite an increase in the unit amount.
10. A drop in the income is also predicted in the number of CDs being sold since each Bulletin will now include a CD containing the entire dataset.
11. A proposal for the NSF to further support the ISC will be submitted in July 2004. We shall apply for a sum of about £ 130,000 - and hope for a matching fund in the order of £ 40,000.- from the Royal Society. These figures, however, are not included in the estimated budgets.

Publications and Presentations made by ISC Personnel

Adams, R.D., P. Bormann, R.E. Engdahl, J. Havskov, B.L.N. Kennett, J. Schweitzer and D.A. Storchak. IASPEI Standard Seismic Phase List, IUGG 2003 Assembly.

Other Activities

Chernobay, I.P. D.A.Storchak. Comparative analysis of both IDC & ISC bulletins (Part I and II). IUGG 2003 Assembly.

Evans, M. S., J-M Kendall, R. J. Willemann, J. Plomerova and L. Vecsey. Development of Automated SKS Splitting Measurement. IUGG 2003 Assembly.

Evans, M. S., J-M Kendall and R. J. Willemann. Development of Automated SKS Splitting Measurement. Fall AGU 2003.

Kebeasy, R., R. J. Willemann, I. P. Chernobay, D. A. Storchak, First Joint Analyses of both IDC and ISC Bulletins, IUGG 2003 Assembly.

Luckett, R. and R J. Willemann. Would Crustal Travel Time Corrections Improve ISC Locations?, AGU 2003 Fall Meeting.

Luckett, R. and R J Willemann. Investigating Alternative Location Methods at the ISC, IUGG 2003 Assembly.

Luckett, R. and R J Willemann. 2003. Travel Time Corrections at the ISC. Fifth Workshop on IMS Location Calibration, Oslo, Norway.

Özel, N., Sasatani, T., Özel, O. Strong Ground Motions during the September 13, 1999earthquake, the Largest Aftershock of the 17th August 1999 Kocaeli, Turkey Earthquake (Mw=7.4), In Press - Tectonophysics (2004)

Özel,N., T. Moriya, Focal Mechanisms of Intermediate-depth Earthquakes beneath Southeastern Hokkaido, Japan -Implications of the Double Seismic Zone, Pageoph, 160 (2003)

Özel, N., T., Sasatani, O., Özel. Site Amplification Study in İstanbul Province, IUGG 2003.

Özel, N., D., Storchak, D., Kalafat. Discrepancy in Earthquake Location between KOERI and ISC, IUGG 2003.

Storchak, D., M. Adrianirina, E.L. Banganan, N. M. Özel, R.J. Willemann, Summary of the ISC Bulletin of events of 2000, IUGG 2003.

Storchak, D.A., J.Schweitzer and P.Bormann (2003). The IASPEI Standard Seismic Phase List, Seism. Res. Lett. 74, 6, 761-772

Willemann, R. J., 2003. Evaluating the fit of alternative hypocentres to arrival times, Bull. Seis. Soc. Am., 93, 519-525.

Willemann, R. J., The role of non-IMS stations in explosion monitoring, Vertic seminar, CTBT Article XIV Conference of 2003.

Willemann, R. J., Linking Seismic Bulletins and Waveforms. IUGG 2003 Assembly.

Willemann, R. J., Finding Waveform Data for Events in the ISC Bulletin. GS/AGU/EUG 2003 Joint Assembly.

Other Activities

Visitors to the ISC in 2003

Oguz Özel	Hokkaido University, Japan
Paul Richards	Lamont Doherty Observatory
Chris Browitt	British Geological Survey
Bernard Massinon	BRGM, France
H Benhallou	USTHB, Algeria
Mike Kendall	Univ. of Leeds
John Young	AWE Blacknest
Anthony Hughes	Ex-ISC Director
Avi Shapira	GII, Israel
Chen Huiqiang and party	Earthquake Office, Guangzhou
Hong Jianshuang	Earthquake Office, Guangzhou