International Seismological Centre

Director's Report

2006

Thatcham, UK
2007 May

STAFF LIST FOR 2006

Dr. A. Shapira (Israel) – Director (Seismologist)

Mrs. M. Aspinwall (UK) – Administration Officer

Miss. M. Bolton (Canada) – Seismologist. (left June 2006)

Dr. P. Dawson (UK) – Data Collection Manager & Developer

Mr. J. Harris (UK) – System Administrator & Developer

Dr. D. Storchak (Russia/UK) – Chief Seismologist

Ms. B. Vera (Colombia) – Seismologist (from February 2006)

Mr. O. Gaspa Rebull (Spain) – System Assistant and Developer. (from July 2006)

Mrs. Baokun Li (China) – Seismologist (from Oct 2006)

Mr. Przemyslaw Kowalski (Poland) – Seismologist (from Oct 2006)

VISITORS TO THE ISC DURING 2006

Dr. Frederick O Simon – UNESCO

Dr. Stephen C Myers – Lawrence Livermore National Laboratory, Livermore, USA

Dr. Bernie Johns – International Affairs Section, Royal Society of London.

2 delegations from the China Earthquake Administration, Beijing, China headed by

Mr. Du Wei, Deputy Director, Department of Earthquake Disaster Prevention, China Earthquake Administration (CEA) and

Prof. Liu Ruifeng , Chief Engineer of China Earthquake Network Center, CENC (CEA)

Dr. G. Ferrari, Storia Geofisica Ambiente, Bologna, Italy.

DIRECTOR'S REPORT 2006

Introduction

During 2006 the ISC published 3 printed issues of the 4-monthly Bulletin, an annual Bulletin for 2003 on CD and an updated earthquake catalogue for 1904-2003 (see seismicity map in Fig. 1).
At the completion of the development updates to the ISCloc system and its assimilation into the routine operations of the ISC at the end of 2005, ISC has begun a new line of developments associated with upgrading its website, exploring the possibility to migrate into a Linux environment and usage of a free relational database system. By the end of 2006 we are confident that we will be able to make a recommendation that such a migration process is advisable and feasible.

The audited financial report for 2006 is attached as a complementary document.

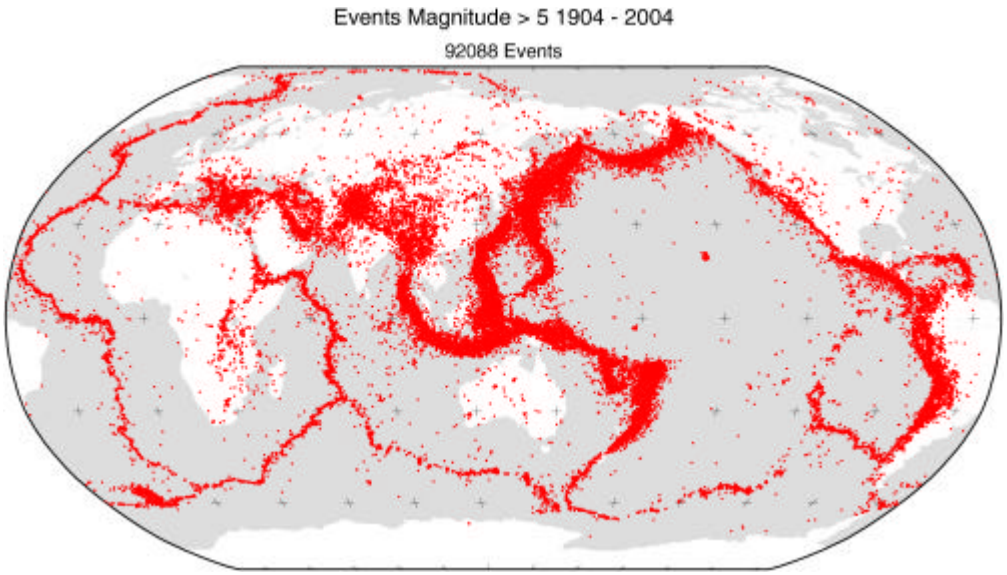

Fig. 1 : World Seismicity 1904-2004 (M>5)

Data Collection

During 2006, normal operational aspects were carried out i.e., inspecting the automated e-mail data acquisition through the Internet and dealing with unknown stations, data entry mistakes, changing of e-mail formats etc. In 2006 the ISC received 7185 data files from 108 agencies (see map in Fig. 2), reporting readings from 4102 seismic stations (see map in Fig. 3) – **the largest number ever to report readings to ISC**. About 89% of the data files were parsed automatically into the ISC database. The remaining 11% required data-correction, parser-correction or new parsers and extensive correspondence with station operators and data providers – a total number of 280 changes to all capture-software-routines (including parsers and ancillary programs). 319 new seismic stations contributed to the data year 2006 (about equal to the number of new stations contributing data during 2005 and 2004). The station information for 329 stations has been updated. 11 agencies either resumed sending their data after a long interruption or started contributing their data (directly or indirectly) to ISC. These agencies are:

HLW
: National Research Institute of Astronomy and Geophysics, Helwan, Cairo, Egypt

MED_RCMT
: MedNet Regional Centroid Moment Tensor solutions

NERS
: GSRAS, Geophysical Survey, Russian Academy of Sciences, North Eastern Regional Seismological Centre, Magadan, Russia

ULE
: Earth Science Department, University of Leeds, UK

INDR
: Inst. Nacional de Recursos Hidraulicos, Santo Domingo, Dominican Republic

LDN
: University of Western Ontario, London,Ontario, Canada

QUI
: Escuela Politénica Nacional, Quito, Ecuador

MERI
: Maharashta Engineering Institute, Nashik, Maharashta, India

SFS
: Real Instituto y Observatorio de la Armada, San Fernando, Spain

NSSP
: National Survey of Seismic Protection, Armenia

ICE
: Instituto Costtariccense De Electricidad, San Jose, Costa Rica

Agencies that sent data during 2005 but did not send data in 2006 are:

ASM
: Dept. of Earth Sciences, University of Asmara, Eritrea - last data sent April 2005

DUSS
: Dept. of Geology, Faculty of Sciences, Damascus University - last data sent July 2005

IAG
: Instituto Andaluz de Geofisica Universidad de Granada, Spain - last data sent June 2005 – plan to send data again in 2007

KISR

Kuwait Institute for Scientific Research, Safat, Kuwait - last data sent July 2005

KLM

Kuala Lumpur, Seismological Division, Malaysian Meteorological Service, Malaysia - last data sent January 2005

LIC

Lamto, Station Geophysique, N'Douci, Ivory Coast - last data sent in October 2005

NIED

National Research Institute for Earth Science and Disaster Prevention, Ibaraki, Japan. Last data sent in November 2005 – resumed in February 2007

PNSN

Pacific Northwest Seismic Network, Department Earth and Space Sciences, University of Washington, Seattle, U.S.A. - No data in 2006 but resumed in January 2007

TAP

Taiwan Weather Bureau, Taipei - last data sent 2005

UAV

Red Sismologica de Los Andes Venezolanos, Laboratorio de Geofisica Universidad de Los AndesMerida, Venezuela - last data sent April 2005

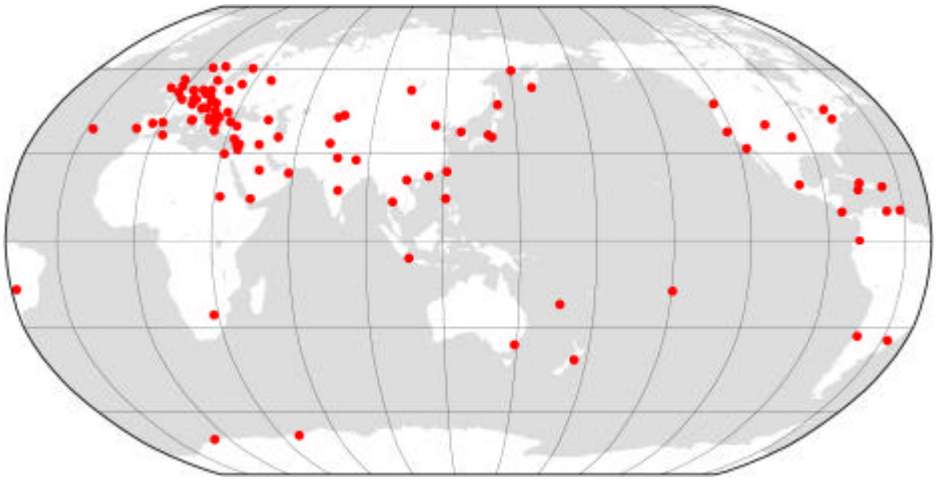

Fig.2 : Seismological Agencies contributing data to ISC (2006 update)

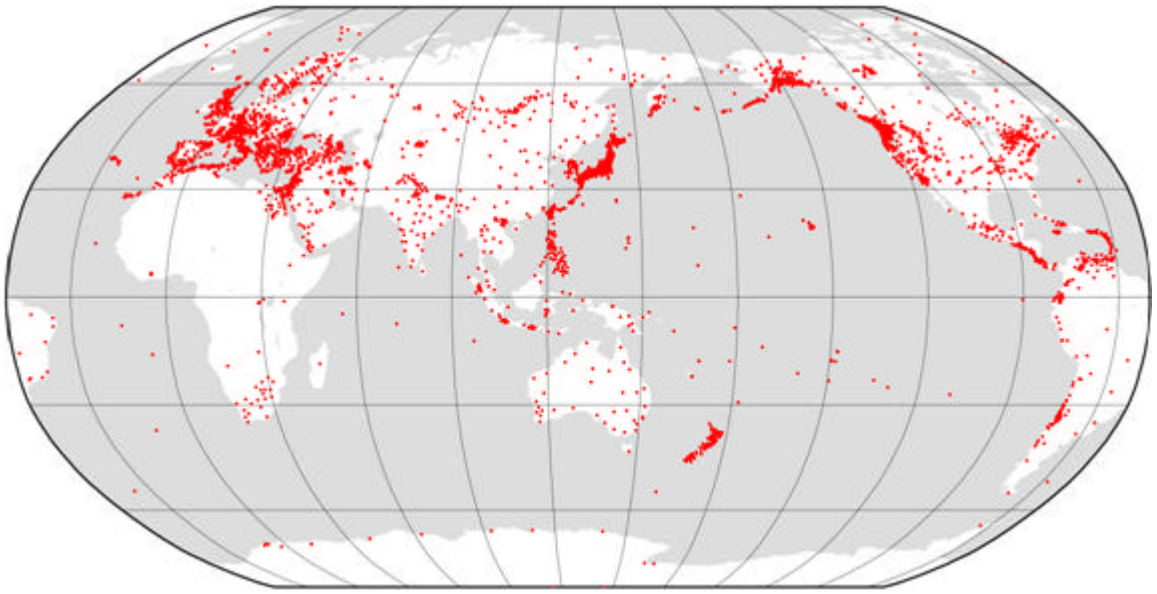

Fig 3: Distribution of stations contributing data for the 2004 ISC Bulletin

In comparison to the year 2005, we had a growth of 2.7 Gb to the 41Gb of seismological data in the database.

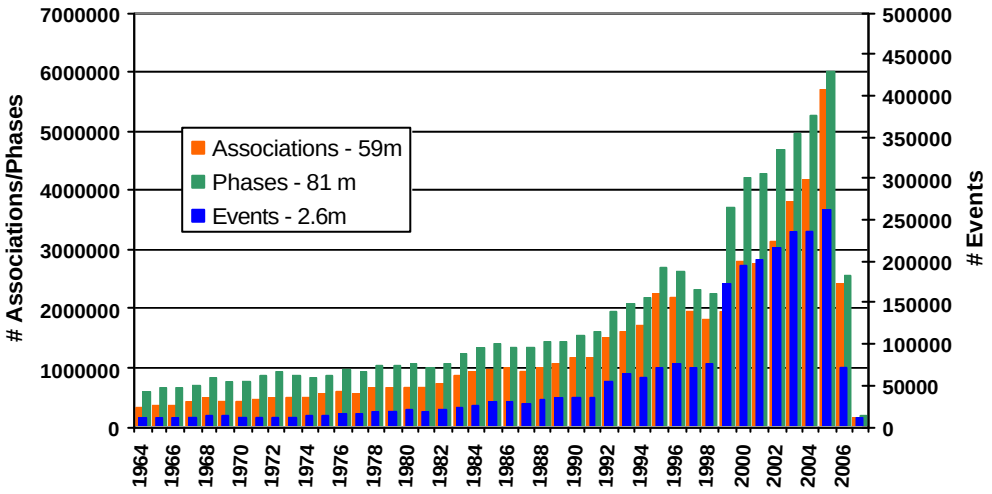

Fig. 4: The annual number of events updated April 2007

Bulletin Review

During 2006 the ISC seismologists reviewed the data covering the period Jan.-Sept. 2004. All events with maximum reported magnitude of 3.5 and larger, along with events with multiple network reports or stations reporting at distances more than 10 degrees, were analysed and where possible relocated. By the end of 2006, 171,429 seismic events had been added to the ISC Bulletin. 30989 of them were reviewed and edited by ISC seismologists. The ISC Bulletin for 2004 was completed in April 2007 and includes in total 235,706 events out of which 43,672 were reviewed and edited. Fig. 5 shows the seismicity of the Earth during 2004, and also indicates which of the depicted events was edited by ISC seismologists.

Figure 6 shows the apparent frequency-magnitude distribution of events occurring during January-November 2004, i.e., excluding the Dec. 2004 Sumatra-Andaman earthquake and its aftershocks. It suggests that the 2004 ISC Catalogue of earthquakes is complete for all events at about magnitude 4.0-4.5 and above. Obviously, catalogue completeness varies from region to region depending primarily on station distribution. Completeness is slightly higher in continental areas and slightly lower in the oceans. The difference is in the order of 0.5 magnitude units.

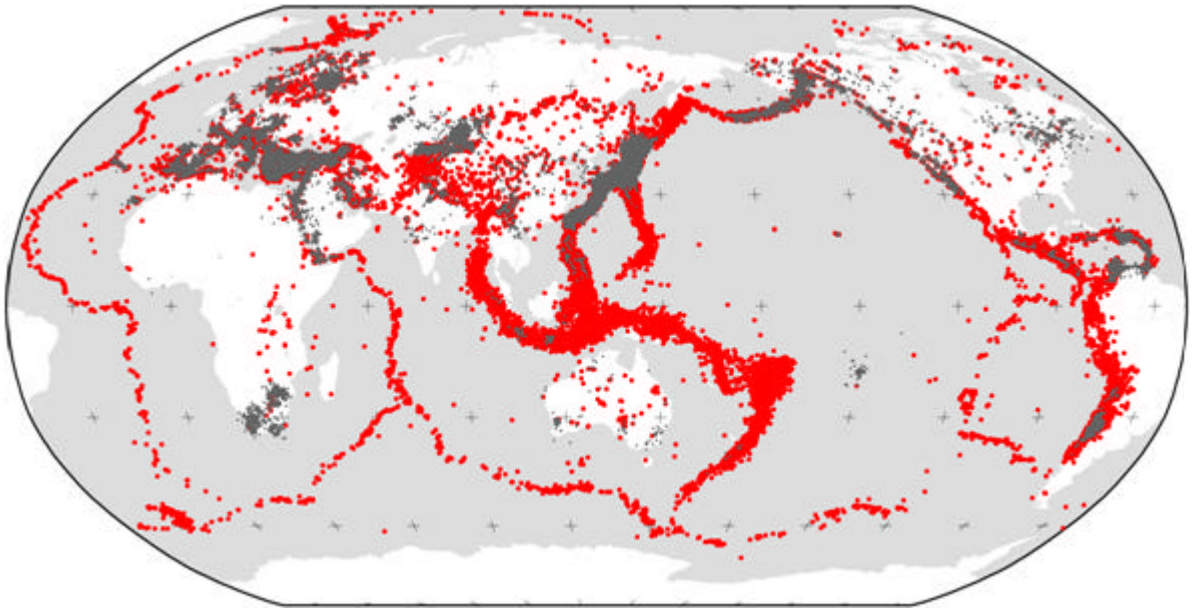

Fig. 5: Earth seismicity during 2004
Red: Epicentres of earthquakes reviewed by ISC seismologists
Grey: Earthquake locations not reviewed by ISC seismologists

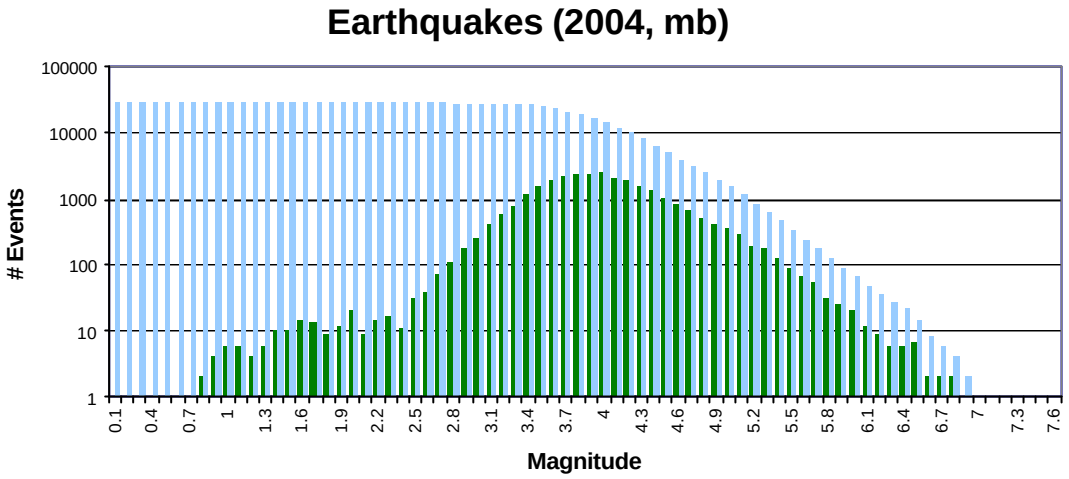

Fig. 6 : Frequency-magnitude distribution of earthquakes in ISC Bulletin, Jan.-Nov., 2004
Blue = Cumulative # Events Green = Actual # Events

In anticipation of the huge amount of additional data to be edited in association with the Sumatra-Andaman earthquake and in an attempt to reduce the gap between publication of the Bulletin and event occurrence, the number of editors has been doubled and now comprises 4 seismologists; Mr. P. Kowalski, Ms. B. Li, Ms. B. Vera (replacing Ms. M. Bolton), and Dr. D. Storchak, the ISC Chief Seismologist. Great efforts were made to train the new recruits and perform the routine analysis tasks simultaneously. A more detailed analysis of the ISC Bulletin for 2004 is being prepared by ISC seismologists and will be posted on ISC web page.

ISC website and FTP service

In 2006, the popularity of the ISC website kept was greater than ever. There were over 1.3 million hits on the ISC website – excluding identifiable web-crawlers which is 14 % more than the previous year and more than twice the year 2002. There were more than 62,000 searches of the ISC database for earthquake information, which was a decrease of 23% compared with 2005. A breakdown of usage by country is shown in Fig. 7.

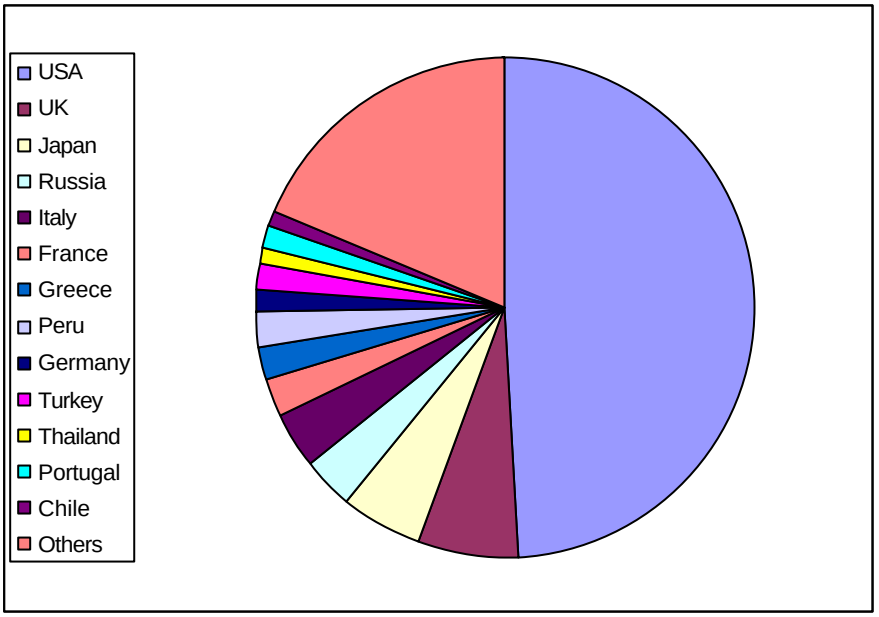

Fig. 7: Distribution of entries to the ISC website

The ISC database is accessible and data are available at the ISC website www.isc.ac.uk. We continue to emphasise the fact that data received by ISC are immediately available to the scientific community. Hypocentre grouping and phase reading association are performed continuously and become available in the comprehensive ISC Bulletin within days after the data arrive and long before it is added to the edited ISC Bulletin.

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 Regional Catalogue.

Additional on-line services

In addition to providing on-line earthquake information and as a service to the seismological community, the ISC provides other on-line information. The main services are:

International Registry (IR) of Seismic Stations and station book – Continued service

The International Registry of Seismic Stations 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'. The ISC website (http://www.isc.ac.uk/IR/reg.html) makes it convenient for network operators to add stations to the Registry via the 'Station Registration' link.
An on-line station book service, added during 2004, complements the on-line station registration service. 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.

Bibliography of Seismology – Current service and future plans

The Bibliography information provided on the ISC website still gains popularity. At present there are no references beyond 1996.

During a visit from a delegation of the China Earthquake Administration, CEA, in November 2006, it was agreed that the CEA will complement ISC bibliography service by designing and maintaining a bibliography of Seismology that focuses on national and regional journals. ISC will help CEA in its efforts to compile such a bibliography and a link to the website would be provided. The aim is for a joint venture with other seismological institutions who might be interested in compiling the information and providing it on-line.

Shear Wave Splitting of SKS Phases – Current service and future plans

Results from the automated shear wave splitting project, undertaken in collaboration with the University of Leeds and performed by Dr. Matthew Evans is available on the ISC web site (see http://www.isc.ac.uk/SKS). We maintain contact with Prof. M. Kendall (currently University of Bristol) and Dr. M. Evans of to provide expertise and supervise automatic S/SKS splitting results as a pre-condition to posting them on ISC website.

Links to Rapid Earthquake Information– A relatively new service

In 2005 introduced a new service (see http://www.isc.ac.uk/realtime.html) that provides links to seismological data centres that provide rapid earthquake information, especially for destructive earthquakes. This service is gaining popularity and during 2006 was visited by almost 7,000 people.

Contact list of Seismologists and Seismological Institutions – Continued service

ISC prepares and maintains a database that list seismologists and seismological institutes who agree to serve as national contact points in case of emergencies associated with earthquakes (web page http://www.isc.ac.uk/contact/index.html). This list contains names and addresses from more than 15 countries. The list of contact names has been extended to provide general contact information about seismological institutions and national data centres that operate in different countries.

Practice of Magnitude determination – A new service.

Following the recommendations made by the IASPEI Working Group on Magnitudes, ISC asked the agencies contributing data to tell about their magnitude determination practice; what is measured on the seismograms and what equations are used. Information received by ISC is made available on the webpage http://www.isc.ac.uk/magnitude/mag_info.html
The table below summarizes the main (most popular) on-line services provided by ISC, the number of entries and the percentage variation when compared to the previous year.

Table 1: Most used on-line services provided by ISC

Service	Entries	Change
ISC Bulletin (search)	~62,000	-23%

Seismic station Information	~7,200	-72%
Real Time Earthquake Information (Links)	~ 6,700	Intro. 2005
Links to Seismologists and Seismo. Inst.	~6,500	Intro. 2005
ISC Bulletin maps	~4,500	-10%
Bibliography	~3,500	- 40%
Contributed bulletins	~1,500	-66%
Download of bulletin Data	15 Gb	+20%
Documentation about ISC location WS	~6,500	
Documentation on ISC Database	~5,000	
Documentation on Data Collection	~3,000	
Director's report for 2005 Documentation on ISC code	~2,400 ~ 2000	
ISCloc documentation	~1,500	
ISF documentation (PDF)	~1,000	

Fig. 8: Distribution of entries and inquiries for data from the on-line ISC Bulletin since 2000

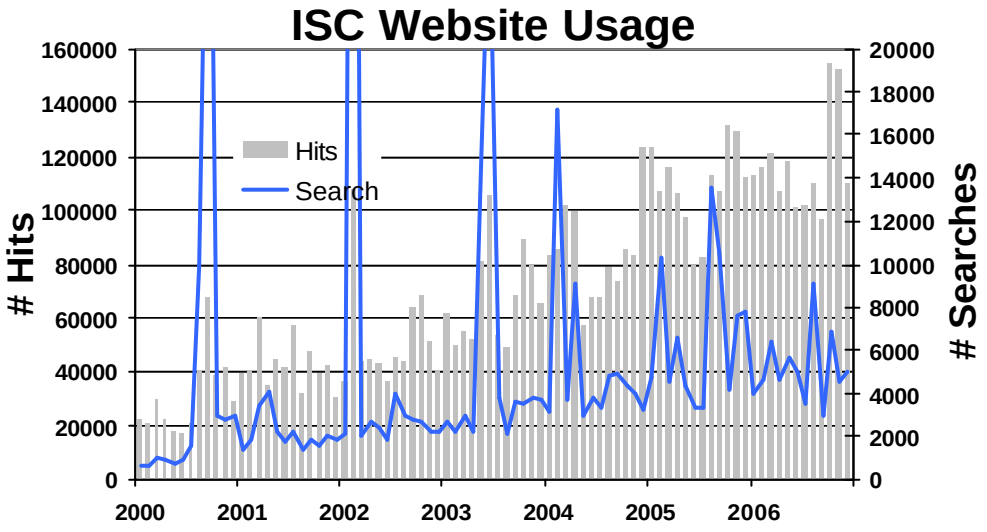

Fig. 8. Distribution of entries and inquiries for on-line ISC Bulletin data since Jan 2000.

FTP service

An anonymous FTP server, ftp://ftp.isc.ac.uk, is used to allow prompt distribution of the results of the ISC's monthly analysis. These files are available very shortly after the completion of each month's editing and allow access to the results much more rapidly than the annual CD.
During the year 2006 we saw a relative increase in using the FTP server, the number of IP addresses visiting that server increased by 48% and reached 626 different addresses. The amount of downloaded data (FFB, ISF and PDF files) has increased by almost 250%.
There were 17 downloads of the ISCloc program and 12 of the ISCbul program, about the same as the previous year. Downloads of station data files has almost doubled (539 in 2006).

Production and Distribution of printed ISC Bulletin and CD-ROMs

Each year the ISC publishes a new volume of the Bulletin of the ISC. Each Bulletin encompasses four months of data and contains printed details of the events reviewed and relocated by the ISC seismologists. An accompanying CD-ROM contains the fully comprehensive Bulletin in FFB and ISF formats with all phase data included even for the smallest un-reviewed events, as well as the full reviewed Bulletin in PDF format for each of the four months. During 2006 we distributed the annual CD-ROMs of the 2003 data, the printed Bulletins of Sept.-Dec. 2003, Jan-Apr 2004 and May-Aug 2004.

Migration to Linux

ISC's IT team; James Harris, Peter Dawson and Oriol Gaspa Rebull have performed the tests regarding the planned transfer from the UNIX system to Linux, the main benefits being cost cuts and performance improvement at the possible reduction in reliability. The ISC currently uses a system based on the Oracle database and Sun Solaris for most of its key operations and has considered the implications for a move to open source database software for operations, that is a Relational Database on PC running Linux. The ISC has already switched it's fileserver to a redundant Linux system and we have swapped the aging Sun Webserver to a Linux machine. Both being considerably cheaper than the currently used systems and database. The performed tests have shown that in a short space of time a PostgreSQL database could be set up on a Linux workstation and ISC code ported to run on the system and provide a major increase in speed over our current system. A decision on this change will be made during 2007.

Improving analysis tools

The ISC seismologists identify needs and means to further improve the tools to analyse and edit the ISC Bulletin. Additional programs were written to provide the seismologists better visualization products to be used during the analysis.

The present system uses the Netscape browser to modify and edit data on the screen. Work has commenced to improve interactive editing by converting these screens to Perl/Tk which is fast, platform-independent and provides a full range of features - menus, buttons, text-entry fields etc. - all in a Graphical User Interface environment. When these new screens are integrated into the editor's system, later this year, they will help to improve the speed and efficiency of the editing process at ISC.

Modernising the ISC Location Procedures

The IASPEI Assembly 2005 in Santiago, Chile passed a resolution to recommend data centres to use modern Earth velocity models to improve travel time estimations of seismic waves in the real Earth. Based on this, the ISC was asked to relocate a few months of its Bulletin and make the results available on its web-site. By the end of 2006 we had prepared an ISC Bulletin for

the period January-October 2004 with two ISC solutions based on AK135 and JB velocity models. Dr. J. Schweitzer from NORSAR and Dr. D. Storchak of ISC are organising a second location workshop during the IUGG meeting in Perugia, 2007 where a thorough review of this Bulletin will be done on a regional basis by colleagues from various countries.

Proceedings of the workshop in Chile were published by the Physics of the Earth and Planetary Interiors in Vol.158, 2006. This is the first consistent set of reviewed publications showing the possible directions for improving ISC location procedures.

Collaboration with IASPEI's Working Groups

When applicable, ISC will support IASPEI activities and implement its resolutions and recommendations. During 2006, ISC was very active in helping the IASPEI Working Group on Magnitudes, to introduce their recommendations for standard amplitude and period measurements to determine different magnitudes and standardize the magnitude formula. In support of the activities of this WG, ISC has encouraged its data contributors to provide information about their practice of magnitude determinations (see above).

ISC took part in the efforts of the IASPEI Working Group for Reference Events to Improve Location and we are in the process of developing an on-line service that will facilitate on-line nomination of candidate events and provide information on reference events.

We are also currently involved with the activities of the working group on Seismic Station and Network Codes that was formed on the initiative of NEIC, EMSC and ISC to better characterise the station in the context of its deployment, to accommodate the need to better credit the owners, operators and data providers and to facilitate the integration of stations of small seismic arrays, temporal deployments and strong motion stations. The first meeting of this WG during the IASPEI 2005 assembly failed to reach any conclusions and discussions are still continuing between interested organisations and individuals (see also web page www.isc.ac.uk/stationcode/).

Training at ISC

From January to June 2006, ISC was pleased to host Hoan Seung Kim from the Korean Meteorological Agency. During his stay, Kim was trained in using ISC location procedures through re-location of Korean earthquakes using different travel time models, different location algorithms and weighting schemes. Kim was also acquainted with the ISC relational data base. We enjoyed having Kim with us and we trust that he benefited from his stay and that his visit will strengthen the cooperation between KMA and ISC.

Taking part in the Activities of international organizations

The ISC was invited and supported by UNESCO to take part in its initiatives known as RELEMR (Reduce Earthquake Losses in the Extended Mediterranean Region) and RELSAR (Reduce Earthquake Losses in the South Asian Region). A. Shapira participated in the RELEMR meetings in Malta (April 2006), Barcelona, Spain (Dec. 2006) and in the RELSAR meeting in Chang Mai, Thailand (Nov. 2006). Earthquake catalogues for the territories covered by these initiatives are under preparation through evaluation of the bulletins of the ISC and EMSC.

The ISC is happy to acknowledge with thanks the receipt of the annual CTBT/IDC reviewed bulletin. This is no doubt a very significant contribution to the completeness of the ISC Bulletin. The ISC Bulletin, which is based on far more data, helps in the evaluation of location accuracy and completeness of the IDC bulletin. Review of particular aspects of the IDC bulletin was also made during the visit of Dr. D. Storchak to IDC.

ISC was encouraged by UN officials involved in the International Geophysical Year and in the Electronic Geophysical Year to take part in the activities. We wait for a response to our suggested involvement.

We have approached the GEOSS organization and applied to become members but despite repeated reminders, we received no response.

FINANCE

The detailed financial statements of the ISC for 2006 were audited by Griffins-Chartered Accountants (Newbury, UK) and approved by Prof. John Woodhouse of ISC Executive Committee. These statements present the state of ISC's financial affairs as at 31 December 2006. The figures, quoted below, are not actual receipts and payments since the accounting is done on an accruals basis. In these accounts the 2005 figures have been partially restated in order to compensate for a miscalculation in the pension computations for previous years.

Income

In 2006, ISC had a total income of £ 394,267 being national contributions and sponsorship from Munich Re, a grant from the Royal Society of London (£ 357), all interest on ISC bank accounts as well as the income from selling ISC publications. This amounted to approximately 3.5% less than the 2006 budget that was approved by the ISC Governing Council.

In comparison with the year before, we had an 11.5% decrease in total income, which can be largely attributed to the deterioration in the $/£ exchange rate that was £1=$1.72 at the beginning of 2006 and 1.959 at the end of the year. During 2006, two more members, each with one unit, joined the ISC Governing Council: the Institute of Geophysics in Warsaw, Poland and the University of the West Indies in Jamaica. At year-end, after 3 consecutive years the membership fees from Korea KIG were unpaid and were written off. The membership of Mexico was expected to lapse and two years' subscriptions were written off but these have happily been paid during early 2007.

Income from printed products was almost the same as in 2005 and some funds, £4,910, were received from the British Council in payment for hosting Mr Hoan Seung Kim from South Korea.

Expenditure

Almost 75% of ISC expenditure is on personnel costs. These costs include: salaries, pension contributions, recruitment and repatriation costs. Salaries follow the UK academic salaries scales. During 2006 there were many changes in personnel with the arrival of three new seismologists and the departure of one and also the recruitment of a seismologist/programmer in the computing department. Some of the computing expenditure, for new machines, was paid for from the Computer Replacement fund.

There was a decrease in travel expenses compared with the previous year, due to the staff acquiring travel grants and the Executive Committee meeting being held in Thatcham.

Reserves

The loss of income over expenditure for 2006 was £14,263. ISC total reserves, comprising the cash in the bank, building and land, the money owed to ISC (debtors) minus the money ISC owes (creditors and remaining mortgage on the building), decreased during 2006 to £448,765. This amount includes the reserve funds of £30,000 set aside by the Governing Council for

emergency use due to exchange rate losses and £ 65,063 for computer replacement funds that have decreased during 2006 by £5,568 for purchases. The ISC has a general reserve of £353,702 (equivalent to just below 12 month's operation of the ISC). This is well within British guidelines for charitable organizations.

Cash Flow

The cash flow in Fig. 9 shows receipts and outlays using dates when transactions were recorded at the bank and the bank balances with US Dollars converted to Sterling using the exchange rate as of the end of each month.

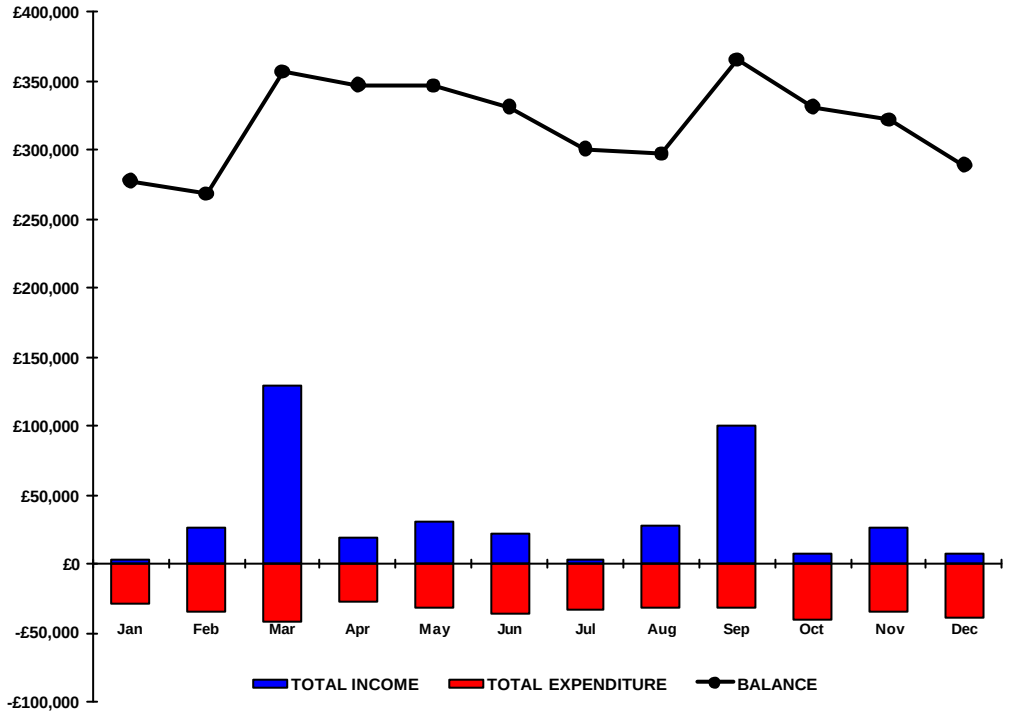

Fig. 9 Income/Expenditure cash flow and cash balance

The ISC has cancelled its £20,000 overdraft facility, as advised by the business manager at the bank, in the knowledge that a new overdraft could be arranged for emergency use if contributions are delayed. If other obligations need to be met then permission from the Governing Council chairman would be requested to use the exchange rate stabilization funds or the computer replacement funds kept in reserve.

ISC's PARTICIPATION IN MEETINGS, WORKSHOPS AND CONFERENCES

Visits by ISC personnel

At the beginning of June in Thatcham, the ISC Executive Committee (EC) held its annual meeting. The EC, chaired by Dr. Gary Gibson, reviewed the Director's report (available on the ISC web pages) and budget for the year 2005 and discussed future plans for the coming years.

Avi Shapira participated in the annual meeting of the Israel Geological Society (Feb. 2006), sponsored by the Geophysical Institute of Israel.

Avi Shapira participated in the 1st European Conference on Earthquake Engineering and seismology and the General Assembly of the European Seismological Commission, Geneva, Switzerland. We thank the organizers for their financial support.

Dmitry Storchak participated in the meeting of the European Geophysical Union Vienna and combined it with a visit to the IDC of the CTBTO where different ways of using ISC Bulletin have been discussed.

Avi Shapira and Maiclaire Bolton participated in the annual meeting of the Seismological Society of America which also commemorated the 100th anniversary of the San-Francisco earthquake. This was used by Avi and Maiclaire to present up-date on the activities of ISC. We thank the Geophysical Institute of Israel for supporting Avi's participation.

During his stay in the USA for the SSA meeting, Avi Shapira paid a visit to the National Earthquake Information Center (NEIC) of the US Geological Survey. Discussions were held with the seismologists at NEIC, covering a wide spectrum of issues of interest to both ISC and NEIC.

A follow-up of the visit to NEIC was a co-ordination meeting between ISC, the National Earthquake Information Center of the USGS (NEIC) and Euro-Mediterranean Seismological Center (EMSC) that took place in Golden, Colorado in September. ISC was represented by James Harris, Dmitry Storchak and Avi Shapira. The three data centres agreed on the need to change the current practice of registering seismic stations and exchanged views on a possible new system for network and station codes. Other topics that were discussed include naming areas that are sub-divisions of the used regionalization scheme (e.g., Flinn-Engdahl regions), using the EIDS (Earthquake Information Distribution System) for data exchange between ISC, EMSC and NEIC, mutual back-up of seismic information, assessments of the location error ellipse and adoption of the IASPEI standards for magnitude determinations. Again, we would like to thank the USGS for the kind hospitality and for funding this visit.

By invitation of UNESCO, Avi Shapira took part in the meetings of the RELEMR and RELSAR as reported above

The last quarter of 2006, gave ISC great possibilities to meet with many of our Asia and Oceania colleagues. A. Shapira, D. Storchak and B. Vera participated in the general assembly of the Asian Seismological Commission in Bangkok where they presented the activities of the ISC and demonstrated the added value of ISC Bulletin to bulletins of local networks.

Publications by ISC personnel

Reviewed

Aspinwall, M., M. Bolton, P. Dawson, J. Harris, A. Shapira and D. Storchak. 2006. The International seismological Centre: An update. In abstracts book of the 1st European Conference on Earthquake Engineering and seismology, p. 277, and in abstracts book of the 100th Anniversary 1906 Earthquake Conference, San Francisco, California, SSA-522.

Bolton, M.K., Storchak, D.A. and Harris, J., 2006. Updating Default Depth in the ISC Bulletin, In Abstracts of the 100th Anniversary 1906 Earthquake Conference, San Francisco, California and in Phys. Earth Planet. Intr., 158:27-45.

Pinsky, V., Y. Gitterman, A. Hofstetter and A. Shapira. 2006. Robust location of surface explosions by a network of acoustic arrays. Geophy. Res. Lett., V. 33, L02317, doi:10.1029/2005GL024304.

Schweitzer, J. and Storchak D.A., 2006. Modernizing the ISC Location Procedures. Editorial, Phys. Earth Planet. Intr., 158:1-3.

Storchak, D.A., 2006. The results of locating the IASPEI GT(0-5) reference events using the standard ISC procedures, Phys. Earth Planet. Intr., 158:4-13.

Abstracts

Engdhal, E. R., P. Richards and A. Shapira. 2006. Acquisition of reference events to improve earthquake locations and to test 3-D Earth models. In abstracts book of the Asian Seismological Commission VI General Assembly, Bangkok, Thailand. p.239.

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