

## 2003 ANNUAL REPORT PUERTO RICO SEISMIC NETWORK

This annual report presents the seismic activity that has been processed by the Puerto Rico Seismic Network (PRSN) of the Department of Geology (UPR-Mayagüez) in the local region (latitude 17.00°-20.00°N and longitude 63.50°-69.00°O) for the year 2003. It also includes a summary of the special initiatives carried out in the PRSN during this year. This report is also available through the internet on our electronic page: <http://rmsismo.uprm.edu>.

### A. Report of the seismic activity for the year 2003

During 2003 the PRSN located 947 earthquakes (Figure 1), this represents a decrease of 2.07% compared with the previous year (2002, 967 earthquakes). This seismic activity is considered normal assuming the average of  $2 \pm 1$  daily earthquakes. As in the previous year, the month of greatest seismic activity was March with a total of 115 earthquakes (2002, 98 earthquakes), whereas the month with the least activity was January with 51, (Figure 2). Of all the earthquakes, only 26 (2.7%) were reported as felt (Table 1 and Figure 3). Of these 26 earthquakes, 2 (May 14 and September 22) were generated out of the domain of the PRSN, therefore, the locations of the National Earthquake Information Center of the United States Geological Service (NEIC/USGS) were used.

The earthquake of greatest magnitude (6.5 in the Richter Scale) occurred on September 22 at 00:45:50 (local time). This strong earthquake was felt extensively throughout the Dominican Republic and Puerto Rico. It was located 15 kms Northwest (NW) of Puerto Plata, approximately 410 kms NW of Mayagüez, in the latitude 19.847° N and longitude 70.666° W, with a depth of 10.0 kms. Its maximum intensity was VII (Modified Mercalli Scale) in Puerto Plata, Dominican Republic (DR) and V in Puerto Rico (PR). The area in PR where most earthquakes were reported as felt were generated in the Southwestern Region of the island with a total of 9 earthquakes, followed by the Virgin Islands Platform with 7 earthquakes (Table 2, Figure 3). The month with most felt earthquakes was March with a total of 9 events (Table 1, Figure 2).

Of the past 10 years, the year 2003 has had the greatest amount of reported felt earthquakes (26 earthquakes), surpassing 2002 during which 22 felt earthquakes were reported (Figure 4). The year with the least amount of felt earthquakes reported was 1997 with 4 earthquakes.

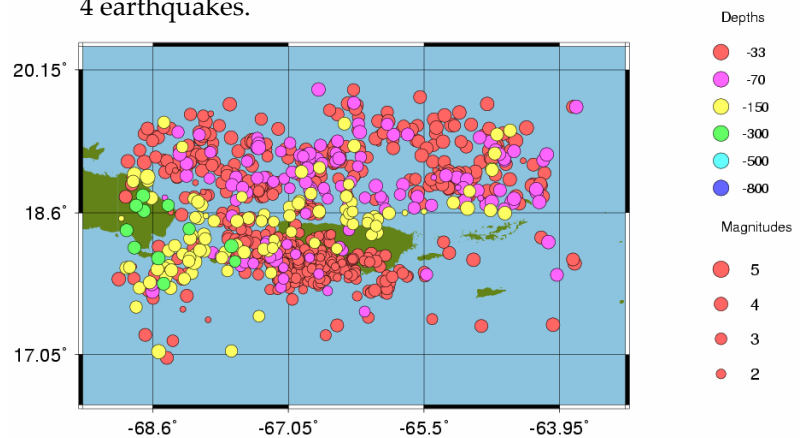


Figure 1. Epicentral map of the earthquakes located by the PRSN for the year 2003 (PRSN-UPRM).

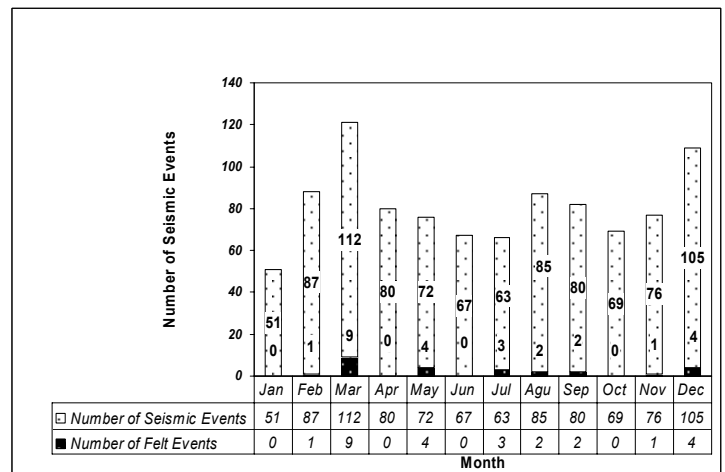
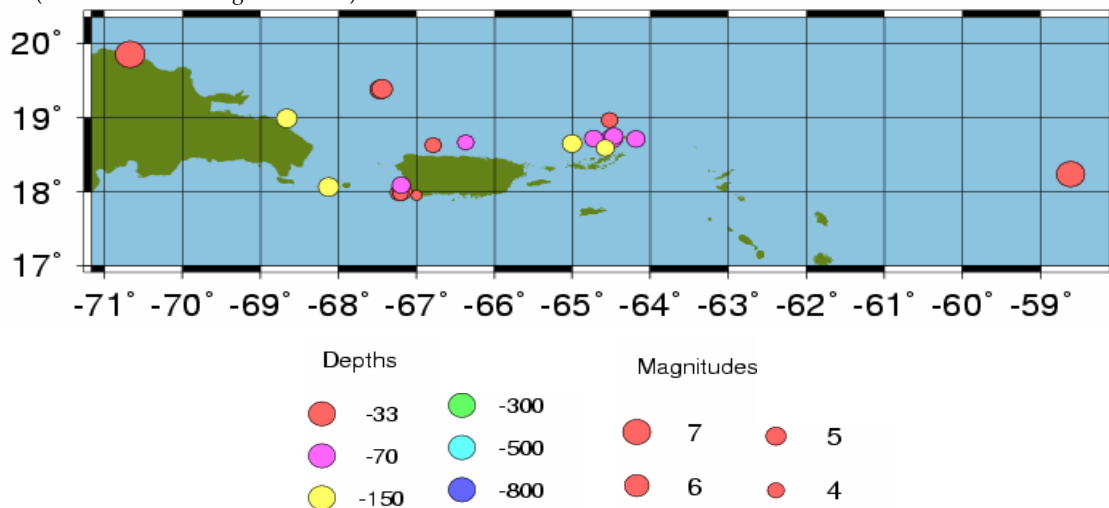


Figure 2. Earthquakes located and reported as felt during 2003 in the Puerto Rico Region by the PRSN.

**Table 1: Felt earthquakes during 2003 (PRSN-UPRM).**

Date	Local Time	Lat. N	Long. W	Depth (km)	Mag.	Maximun Intensity (MM)	Location
2003/02/17	02:57:03	18.717	64.491	43.6	4.6	III - East side of Puerto Rico and the Virgen Islands	15 km West of Anegada (BVI)
2003/03/20	21:09:55	18.066	68.127	97.2	4.7	V - West side of Puerto Rico	105 km West of Mayagüez
2003/03/22	14:25:42	17.988	67.218	1.6	4.1	V - Cabo Rojo, Puerto Rico	West Coast of Cabo Rojo
2003/03/22	15:21:01	17.984	67.202	4.9	3.3	III - Cabo Rojo, Puerto Rico	West Coast of Cabo Rojo
2003/03/22	15:44:49	18.036	67.190	3.9	3.4	III - Cabo Rojo, Puerto Rico	West Coast of Cabo Rojo
2003/03/22	16:07:22	17.950	66.995	4.6	2.2	II - Cabo Rojo, Puerto Rico	South Coast of Lajas
2003/03/22	16:20:53	18.029	37.168	5.2	3.3	III - Cabo Rojo, Puerto Rico	West Coast of Cabo Rojo
2003/03/22	16:35:21	17.999	67.215	4.5	2.9	III - Cabo Rojo, Puerto Rico	West Coast of Cabo Rojo
2003/03/22	19:56:33	17.961	67.178	9.9	2.6	III - Mayagüez, Puerto Rico	West Coast of Cabo Rojo
2003/03/23	19:16:33	18.005	67.155	0.8	3.5	III - Cabo Rojo, Puerto Rico	West Coast of Cabo Rojo
2003/05/07	08:57:01	18.650	65.003	116.2	4.2	V - East side of Puerto Rico	North of St. Thomas (USVI)
2003/05/14	02:03:35*	18.24*	58.61*	33*	6.4 mb*	IV - Northeast side of Puerto Rico	795 km East of San Juan 345 km East of Barbuda
2003/05/20	20:58:35	18.000	67.199	0.6	3.3	III - Cabo Rojo	West Coast of Cabo Rojo
2003/05/21	02:26:54	17.975	67.201	1.0	3.3	II - Cabo Rojo	West Coast of Cabo Rojo
2003/07/08	15:07:00	18.088	97.194	49.5	4.1	IV - West of Puerto Rico	1 km Northwest of Cabo Rojo
2003/07/13	09:55:37	18.716	64.182	39.7	4.0	III - Saint John (USVI) and Tortola (BVI)	15 km East of Anegada (BVI)
2003/07/28	15:42:10	18.723	64.725	64.1	3.9	III - Saint Thomas (USVI)	45 km al North of Tortola (BVI)
2003/08/11	8:22:29	18.628	66.783	20.7	3.8	IV - Manatí, Hatillo, Utuado and Ponce, Puerto Rico	16 km North of Hatillo
2003/08/20	14:21:51	18.596	64.576	125.9	3.9	III - Tortola (BVI)	15 km North of Tortola (BVI)
2003/09/22	00:45:50*	19.847*	70.666*	10*	6.5 mb*	VII - Puerto Plata, DR IV-V - Puerto Rico	15 km Northwest of Puerto Plata, DR
2003/09/23	08:08:15	18.965	64.519	15	3.8	III - Saint Thomas (USVI)	65 km Northeast of Tortola (BVI)
2003/11/09	17:11:18	18.754	64.471	34.5	3.9	IV - Tortola (BVI)	16 km al West of Anegada (BVI)
2003/12/05	23:33:28	19.381	67.460	25.0	5.2 mb*	IV - West side of Puerto Rico	106 km North-Northwest of Aguadilla
2003/12/06	00:33:11	19.384	67.435	25.1	4.7 mb*	III - West side of Puerto Rico	106 km al N-NW of Aguadilla
2003/12/14	16:51:57	18.667	66.365	66.2	3.7	III - Guaynabo and Humacao, PR	20 km North of Vega Baja
2003/12/25	02:55:24	18.992	68.659	130.0	4.6	IV - Aguada and San Sebastián, Puerto Rico	40 km North of Higuey, DR and 165 km Northwest of Aguadilla

\* Source USGS (United States Geological Service)



**Figure 3. Epicentral map of felt earthquakes in Puerto Rico and the Virgen Islands for 2003 (PRSN-UPRM).**

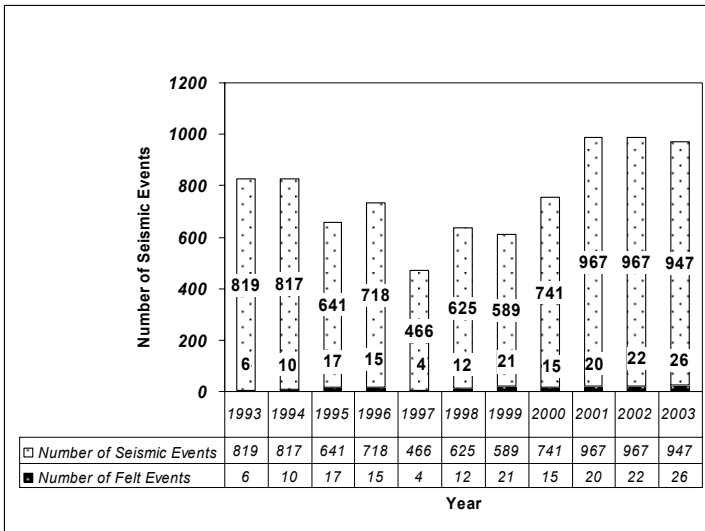


Figure 4. Earthquakes located or reported as felt in the Puerto Rico Region from 1993 to 2003 by the PRSN (PRSN-UPR/RUM).

The seismicity for this year was extensively distributed all over the Puerto Rico region, although within the island, there was a slightly greater concentration of earthquakes in the Southwest. Nevertheless, it is important to clarify that in the seismic region of the Southwest of Puerto Rico only 59 of these earthquakes were located. The seismic region with greatest activity was the 19° N Fault Zone with 109 seismic events (Table 2), followed by the Sombrero Seismic Zone, where 85 earthquakes were located. The regions with the least seismic activity during 2003 were the Saint Croix Platform and the Southeastern Region of Puerto Rico with one earthquake in each. During this year, the depths of the earthquakes varied from 0.1 km to 177.4 km (Figure 5), being the earthquakes with depths from 0 to 25 km the most frequent (571 earthquakes).

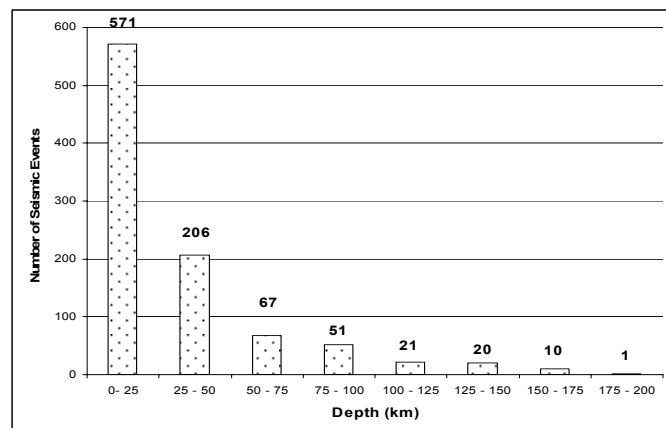


Figure 5. Distribution of earthquakes by depth for 2003 in the Puerto Rico Region (PRSN-UPRM).

Table 2: Distribution of the seismicity by seismic regions during 2003.

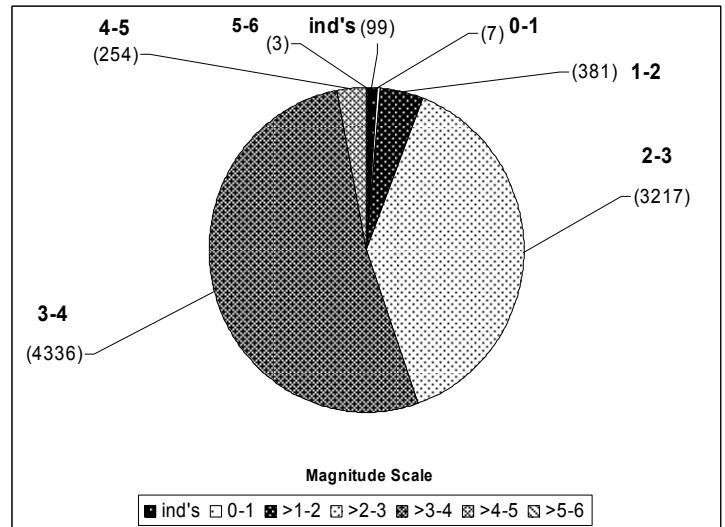
Seismic Region	Total of Earthquakes	Felt Earthquakes
19° N Fault Zone	109	0
Sombrero Seismic Zone	85	0
PR Trench	79	2
South Region of PR	73	1
Mona Passage	71	1
South of PR	69	0
Central Region of PR	65	0
Oriental Region of DR	62	0
Septentrional Fault Zone	60	1
Southwest Region of PR	59	9
North of PR	48	2
Mona Canyon	44	0
West Region of PR	30	1
Virgen Islands Platform	27	7
West of PR	27	0
Muertos Trench	16	0
East of PR	4	0
Virgen Islands "Depression"	4	0
Barlovento Islands	4	0
North Region of PR	4	0
Northeast Region of PR	3	0
East Region of PR	2	0
St. Croix Platform	1	0
Southeast Region of PR	1	0

Nine earthquake swarms occurred in the Puerto Rico Region in 2003. The first and largest of these swarms occurred between March 22-26 in the Southwestern Region of PR, from the western coast of Cabo Rojo to the Lajas coast. During these days, the PRSN located a total of 26 earthquakes (8 felt events), 14 smaller earthquakes were detected that could not be located due to their size. Another large swarm, with a total of 20 earthquakes, occurred on September 1, 65 km North of Arecibo, in the 19° N Fault Zone. The seismic swarms generated during 2003 are described in Table 3.

**Table 3: Description of the seismic swarms which occurred during 2003 (PRSN-UPRM).**

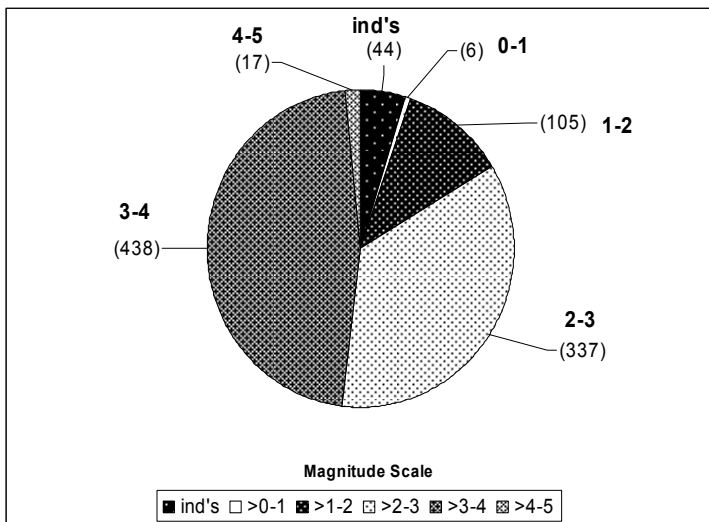
Swarms Location (zone)	Period (Date)	Number of Earthquakes
Southwest Region of PR	March 22-26	26
Whiting Basin	May 12-13	5
Southwest Region of PR	May 20-21	5
Ponce Area, PR	June 10-25	8
Sombrero Seismic Zone	August 2-3	5
Fault Zone of the 19 °N	September 1	20
PR Trench	November 27-29	5
Sombrero Seismic Zone	December 2-4	6
PR Trench	December 5-14	11

The magnitudes calculated by the PRSN varied from 1.0 to 4.7, although for the felt events they varied from 2.2 to 6.5. Magnitudes greater than 5.0 were calculated by the United States Geological Service. The range of magnitudes with the greatest number of earthquakes was 3-4 with 438 earthquakes, followed by magnitudes of [2-3] (Figure 6), the same as in the previous year (2002). During the past 10 years, the tendency of the seismic distribution by magnitude is similar (Figure 7).

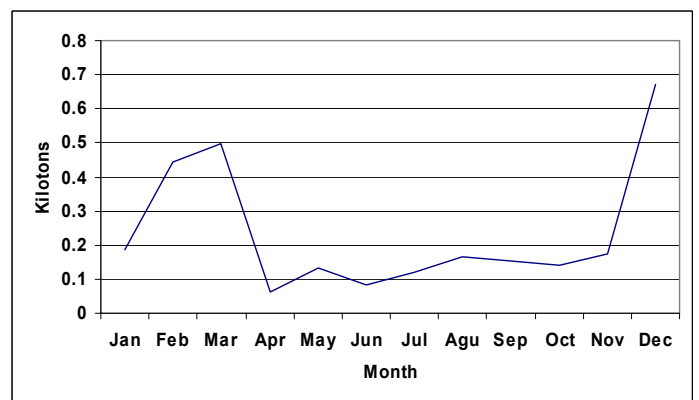


**Figure 7. Distribution of the earthquakes by magnitude located between 1993 and 2003 in the Puerto Rico Region by the PRSN (PRSN-UPRM).**

During 2003, the greatest liberation of energy occurred in December with 0.67 kilotons (Figure 8), followed by the month of March with 0.50 kilotons. Although from 1999 to 2002 there has been an increase in the energy liberated in our region (Figure 9), this last year (2003, 2.84 kilotons) there was a decrease of 4.28 kilotons compared with the previous year (2002, 7.12 kilotons). The total of energy liberated during this year (2.84 kilotons) is equivalent to a sixth part of the energy liberated by the Hiroshima bomb. Since 1993 to the present (2003), the PRSN has located 8297 earthquakes in the Puerto Rico Region, 254 earthquakes more than in the period from 1992 to 2002 (8043 earthquakes).



**Figure 6. Distribution of the earthquakes by magnitude located during 2003 in the Puerto Rico Region by the PRSN (PRSN-UPRM).**



**Figure 8. Energy Liberated in the Puerto Rico Region during 2003 (PRSN-UPRM).**

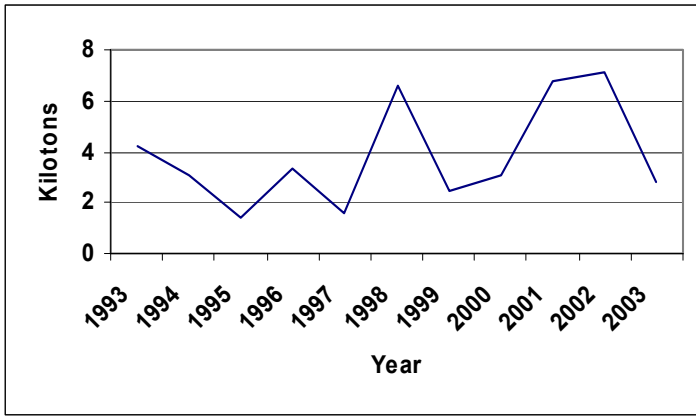


Figure 9. Energy Liberated in the Puerto Rico Region from 1993 to 2003 (PRSN-UPRM).

### B. Seismic Stations.

During 2003, 24 of the PRSN seismic stations (of a total of 28) were operational; of these, 11 are broadband and 13 are short period stations (Figure 10). The seismic station of Saint Croix in the Virgin Islands was reinstalled at a new location.

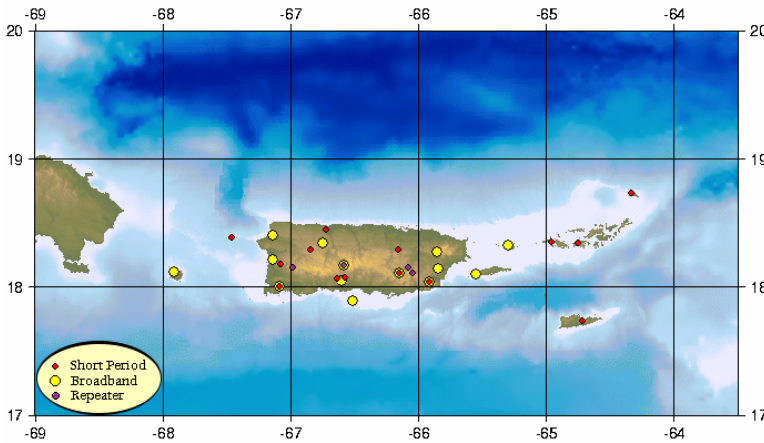


Figure 10. Map with the stations operated by the PRSN during 2003 in the Puerto Rico Region (PRSN-UPRM).

### C. Important initiatives of the Puerto Rico Seismic Network during 2003.

As of February 1, 2003, the PRSN extended its working hours to include Saturdays (8:00 am – 4:30 pm). Activities on Saturdays are focused on earthquake analyses and tours of the facilities (this is in addition to the regular work schedule from Monday to Friday from 7:00 am to 6:00 pm). This innovation was possible thanks to the funds granted to the PRSN by Law 106 of the Government of Puerto Rico. These funds also provided for the contracting of new full-time personnel

(a data analyst, an electronic technician, a computer specialist, a secretary, an educational activity coordinator and a handyman).

During the period February to April 2003, the PRSN contracted the Paleoseismologist, Dr. Carol Prentice, from the United States Geological Survey, who focused her research on trenching the South Lajas Valley Fault, Southwestern Puerto Rico.

From April 29 through May 2 a very successful Annual Meeting of the Seismological Society of America (SSA 2003) was held in the Caribe Hilton Hotel in San Juan, PR. More than 300 seismologists, engineers, technicians and teachers attended this conference. The organizing committee for this convention was formed by personnel of the Puerto Rico Seismic Network (PRSN) and the Puerto Rico Strong Motion Program (PRSM), as well as personnel of the Departments of Geology and Civil Engineering, of the University of Puerto Rico at Mayagüez. The fact that this important meeting was held in the Island, has helped the seismological community develop greater awareness of the seismic and tectonic environment of the Puerto Rico Region and the Caribbean. It was during this conference that the United States Geological Survey presented the new Seismic Hazard Map for Puerto Rico and the Virgin Islands. To obtain more information about this map you can visit the electronic page of the USGS National Seismic Hazard Mapping Project (<http://geohazards.cr.usgs.gov/>).

On September 22, 2003 the Puerto Plata, DR earthquake occurred, and although it was located out of the domain of the PRSN, it was felt extensively in Puerto Rico. The earthquake and 158 of its aftershocks (as of December 9, 2003) were registered by the PRSN. Some of the aftershocks were reported as felt in the DR. For those for which there was sufficient data, the PRSN generated locations. In October, the PRSN obtained, as a loan from the IRIS Consortium (Incorporated Research Institute for Seismology), 10 temporary seismic stations. The data registered by these stations, in the 2 months (October to December) of operation, will be analyzed jointly with those of the PRSN, the seismic networks of the DR and other worldwide networks. With these data, we expect to achieve a better understanding of the

faults in that region, some of which extend to the region north of Puerto Rico. For more information of the Puerto Plata earthquake and its aftershocks, you can visit the PRSN electronic page (<http://rmsismo.uprm.edu>).

During 2003 the first phase of the “Puerto Rico Tsunami Warning and Mitigation Program” (FEMA-UPR) culminated. Personnel from the PRSN, Department of Marine Sciences (UPRM), and the Department of Social Sciences (UPRM) participated. Tsunami flood maps were prepared for Puerto Rico as well as other tsunami related initiatives took place. To obtain the maps, as well as information about this project, you can visit the electronic page of the program (<http://poseidon.uprm.edu>). The program will continue in 2004 with the auspice of the Puerto Rico State Emergency Management Agency.

This year the educational program was reinforced. As of August 2003 the PRSN has an Educational Activity Coordinator. During 2003 the PRSN educational program impacted: 99 private and public schools, 22 communities through the State Agency for Emergency Management and the Municipal Office for Emergency Management, 19 governmental agencies, 9 groups of the general public and 11 private groups (for a total of 156 educational activities). The educational program is a joint initiative of the PRSN and the PRSMN.

During 2002 the Puerto Rico Seismic Network and the Puerto Rico Strong Motion Program External

Advisory Committee was constituted, it is composed by Dr. Harley Benz of the United States Geological Service and by the Dr. Tim Ahern of Incorporated Research Institute for Seismology Institutions. This committee met twice during 2003 and favorably evaluated the operation of the networks.

Besides the continuous updating of the PRSN's Home Page with the most recent results of the seismicity for the Puerto Rico Region, during 2003 improvements were made permitting users to access the monthly seismicity reports and the felt earthquake bulletins. The online search program for the catalogue of earthquakes of the PRSN was improved, permitting users to carry out circular searches as well as searches by region and by quality of locations. Improvements were also made to the online questionnaire to report felt earthquakes. In September, the Puerto Plata earthquake and its aftershocks were added to the web page. Towards the end of 2003 a new design and the implementation of a new web page with the standards of the University of Puerto Rico at Mayagüez (UPRM) was begun.

#### **D. Financing**

The operation, the improvements and the projects carried out by the PRSN during this year have been possible thanks to the assignment of funds by the University of Puerto Rico (UPR), the state government (Law 106, 2003) and the federal government. Federal funds come from FEMA and the US ARMY CORPS.

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