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A COASTAL HAZARDS DATA BASE FOR THE U.S. GULF COAST

Contributed by

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MASTER

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ABSTRACT

GORNITZ, V. M. and T. W. WHITE. 1994. A Coastal Hazards Data Base for the U.S. Gulf Coast, ORNL/CDIAC-60, NDP-043B, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 134 pp.

This document describes the contents of a digital data base that may be used to identify coastlines along the U.S. Gulf Coast at risk to sea-level rise. The data base integrates point, line, and polygon data for the U.S. Gulf Coast into 0.25° latitude by 0.25° longitude grid cells and into 1:2,000,000 digitized line segments that can be used by raster or vector geographic information systems (GIS) as well as by non-GIS data base systems. Each coastal grid cell and line segment contains data on elevation, geology, geomorphology, sea-level trends, shoreline displacement (erosion/accretion), tidal ranges, and wave heights.

To allow for the identification of coastlines at risk from sea-level rise, 7 of the 22 original data variables in this data base were classified by vulnerability and used to create 7 relative risk variables. These relative risk variables range in value from 1 to 5 and may be used to calculate a coastal vulnerability index for each grid cell and/or line segment. The data for these 29 variables (i.e., the 22 original variables and 7 risk variables) have been placed into the following data formats:

- (1) Gridded polygon data for the 22 original data variables. Data include elevation, geology, geomorphology, sea-level trends, shoreline displacement (erosion/accretion), tidal ranges, and wave heights.
- (2) Gridded polygon data for the seven classified risk variables. The risk variables are classified versions of: mean coastal elevation, geology, geomorphology, local subsidence trend, mean shoreline displacement, maximum tidal range, and maximum significant wave height.
- (3) 1:2,000,000 line segment data containing the 29 data variables (i.e., the 22 original data variables and the seven classified risk variables).
- (4) Supplemental point data for the stations used in calculating the sea-level trend and tidal range data sets.
- (5) Supplemental line segment data containing a 1:2,000,000 digitized coastline of the U.S. Gulf Coast as defined by this document.

These data are available as a Numeric Data Package (NDP) from the Carbon Dioxide Information Analysis Center (CDIAC). The NDP consists of this document and machine-readable files available on 9-track magnetic tape, 8mm tapes, quarter inch tape cartridges, IBM-formatted floppy diskettes, and CD-ROM, and through Internet using the File Transfer Protocol (FTP) from CDIAC's anonymous FTP area. This document provides sample listings of the data and detailed descriptions of the file formats; offers FORTRAN and SASTM retrieval program listings; describes the methods used in calculating each variable; discusses the sources, restrictions, and limitations of the data; and provides five ARC/INFOTM export coverages and flat ASCII data files containing these data.

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PART 1
INFORMATION ABOUT THE DATA PACKAGE

1. Name of the Numeric Data Package

A COASTAL HAZARDS DATA BASE FOR THE U.S. GULF COAST

2. Contributors

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3. Keywords

Coastal hazards; risk assessment; sea-level trends; sea-level rise; elevation; geology; geomorphology; coastal landforms; subsidence; erosion; accretion; tidal range; wave height; geographic information system.

4. Background Information

Effective coastal management requires the ability to project the response of coastal zones to long- and short-term climate variations, since any change in the climatic processes will ultimately affect the coastal zone in some way. For example, during the Pleistocene glaciation, beginning about 2,500,000 years ago and persisting until about 10,500 years ago, when the mean global surface air temperature was cooler than at present, the fixation of large amounts of ocean water resulted in a reduction of the world's sea levels by about 90 to 120 m (Doerr 1990, Fairbanks 1989).

Variations in sea levels and air temperatures of sizeable magnitude can profoundly affect the maximum intensity and frequency of storms and, as a result, increase or decrease erosion rates in coastal areas (Emanuel 1988). The effects of coastal storms range from accelerated shoreline erosion (Dolan et al. 1988) to loss of life and property (Case and Mayfield 1990). Added to these concerns is a fear that climatic change (possible causes include: the greenhouse effect, ozone depletion, reduced cloudiness, etc.), especially that caused by an increase in the world's mean global surface air temperatures, may cause the world's current rate of sea-level rise to increase (Houghton et al. 1990 and 1992).

The prediction of the future response of coastal zones to changes in sea level or storm intensity requires information on the past and current state of the coast (Smith and Piggott 1987). In 1987, the U.S. Department of Energy's Atmospheric and Climate Research Division funded Dr. Vivien M. Gornitz (Goddard Institute for Space Studies) and the *Carbon Dioxide Information and Analysis Research Program (CDIARP): Resource Analysis Project* at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, to develop a Coastal Hazards Data Base to provide information on the past and current state of world coastlines. The proposed data base would contain information on relative sea-level trends, elevation, vertical land movements, horizontal displacement (erosion/accretion), coastal geomorphology, and geology (Gornitz and Kanciruk 1989). When complete, the data base would be used within a Geographic Information System (GIS) to identify coastal areas of the United States (and possibly Europe, Australia, Mexico, and Canada) currently at risk to inundation and erosion, and whose risk would increase if eustatic levels increased (U.S. Department of Energy 1987; 1988; 1989; 1990; 1991).

The research and data acquisition phase of this project ended in 1991. The data gathered over the lifetime of the project are archived at the CDIAC at ORNL. From these data, CDIAC and the principal investigators plan to produce a set of NDPs for the continental United States. The first NDP of this set, for the U.S. East Coast, is available from CDIAC (Gornitz and White 1992). This NDP documents the data for the Gulf Coast. NDPs for the U.S. West Coast, Hawaiian Islands, and Alaskan coastlines are in progress or are being planned. Data have also been collected for the remainder of North America (i.e., Canada and Mexico) and are being evaluated. The data for the U.S. Gulf Coast offered in this NDP may be used to calculate the relative vulnerabilities of different areas along the U.S. Gulf Coast to projected increases in air and sea surface temperatures and sea-level change. This information will be useful to other researchers, government planning agencies, the private sector, and educational institutions interested in determining the present and future vulnerabilities of coastal zones to erosion and sea-level rise.

The data base described here comprises data extracted from a variety of sources, including publications of the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corp of Engineers, the U.S. Geological Survey (USGS), universities, and other federal and state agencies. These data varied in scale and format. To facilitate data analysis, these data have been referenced to a grid of 0.25° latitude by 0.25° longitude and to a 1:2,000,000 digitized U.S. Gulf coastline. This NDP defines the U.S. Gulf Coast as extending from Key West, Florida to the Texas-Mexico border (Fig. 1).

Fig. 1. The U.S. Gulf Coast.

5. Applications of the Data

This coastal hazards data base contains information on elevation, bedrock geology, geomorphology (coastal landforms), sea-level trends, horizontal shoreline displacement (erosion), tidal ranges, and wave heights. These data variables were selected for inclusion in this data base on the basis of the roles they play in determining the vulnerability of coastal areas to variations in sea level and long-term erosion.

The 29 data variables in this data base effectively measure two basic risk factors, erosion and inundation. The erosion risk was determined on the basis of historical shoreline displacement, resistance to erosion (geology, geomorphology), and ocean forcing factors (tidal ranges and wave heights). The inundation risk was estimated on the basis of sea-level trends and elevation data.

This data base, and the corresponding coastal vulnerability indices (CVIs) that may be calculated using this data base, may be used to identify coastal zones that are at risk from coastal erosion or possible changes in relative sea level.

Several studies have evolved from this series of NDPs (e.g., Daniels et. al. 1992, 1993). One such study added climatological data and developed new CVIs (Gornitz et. al. 1994).

6. Definition of Standard Terms and Concepts

The 29 data variables within this data base have been placed into five data groups (i.e., two primary groups, two supplemental data groups, and an auxiliary data group). The following terminology is used throughout this documentation.

Data variable—A single, discrete data item within a data group or data set (e.g., data set=elevation, data variable=mean elevation).

System variable—A numeric variable that geographically identifies data variables within a data group.

Data set—A collection of data variables that have been derived from a single data source, such as the mean and maximum elevation variables.

Data group—A collection of data variables that have been placed into a single ARC/INFO™ export file and a comparable flat ASCII file.

Data base—All data groups within this NDP.

Original data variables—The 22 data variables from the seven data sets presented within this NDP (i.e., mean, maximum, and minimum elevation, and the number of 5' National Geophysical Data Center (NGDC) grid cells used in deriving the data values; geology; geomorphology; relative sea level trend, long-term geologic trend, corrected sea-level trend, local subsidence trend, and years of record of the gauge stations used in calculating these values; mean, maximum, and minimum shoreline displacement, and the number of 3', 7.5', or 15' grid cells used in deriving the data values; mean and maximum tidal range, mean tide level, and the number of tide gauge stations used in calculating these variables; the 20 year mean wave height, maximum significant wave height and its standard deviation).

Relative risk variables—The 7 classified risk variables derived from each of the following: mean coastal elevation, geology, geomorphology, local subsidence trend, mean shoreline displacement, mean tidal range, and maximum significant wave height.

The two primary data groups are stored as exported ARC/INFO™ polygon coverages and as flat ASCII files. The first group contains the original 22 data variables. The second data group contains the 7 relative risk data variables. To allow these data to be used by raster and vector-based GISs, as well as non-GISs data base systems, each polygon is defined as a 0.25° latitude by 0.25° longitude grid cell. This grid covers the Gulf Coast of the U.S. and is outlined by the following coordinates: 100°W, 24°N; 100°W, 32°N; 80°W, 32°N; and 80°W, 24°N. The grid origin (i.e., grid cell number 1) is 100°W, 24°N and 2561 grid cell identification numbers increase from left to right, bottom to top (Fig. 2).

2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500
2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420
2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340
2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260
2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180
2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
1841	1842	1843	1844	1845	1846	1847	1848	1849	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859	1860
1761	1762	1763	1764	1765	1766	1767	1768	1769	1770	1771	1772	1773	1774	1775	1776	1777	1778	1779	1780
1681	1682	1683	1684	1685	1686	1687	1688	1689	1690	1691	1692	1693	1694	1695	1696	1697	1698	1699	1700
1601	1602	1603	1604	1605	1606	1607	1608	1609	1610	1611	1612	1613	1614	1615	1616	1617	1618	1619	1620
1521	1522	1523	1524	1525	1526	1527	1528	1529	1530	1531	1532	1533	1534	1535	1536	1537	1538	1539	1540
1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460
1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380
1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300
1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220
1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140
1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980
881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820
721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740
641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580
481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Fig. 2. Grid cells (0.25° by 0.25°) and line segments (1:2,000,000) used in the raster (ASCII) and vector (ARC/INFO™) files. The value shown within each cell is the grid cell identification number.

2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520
2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440
2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360
2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280
2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200
2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120
2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880
1781	1782	1783	1784	1785	1786	1787	1788	1789	1790	1791	1792	1793	1794	1795	1796	1797	1798	1799	1800
1701	1702	1703	1704	1705	1706	1707	1708	1709	1710	1711	1712	1713	1714	1715	1716	1717	1718	1719	1720
1621	1622	1623	1624	1625	1626	1627	1628	1629	1630	1631	1632	1633	1634	1635	1636	1637	1638	1639	1640
1541	1542	1543	1544	1545	1546	1547	1548	1549	1550	1551	1552	1553	1554	1555	1556	1557	1558	1559	1560
1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480
1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400
1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320
1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240
1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160
1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080
981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920
821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840
741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760
661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680
581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Fig. 2. (continued)

2521	2522	2523	2524	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540
2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460
2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380
2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300
2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220
2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140
2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
1801	1802	1803	1804	1805	1806	1807	1808	1809	1810	1811	1812	1813	1814	1815	1816	1817	1818	1819	1820
1721	1722	1723	1724	1725	1726	1727	1728	1729	1730	1731	1732	1733	1734	1735	1736	1737	1738	1739	1740
1641	1642	1643	1644	1645	1646	1647	1648	1649	1650	1651	1652	1653	1654	1655	1656	1657	1658	1659	1660
1561	1562	1563	1564	1565	1566	1567	1568	1569	1570	1571	1572	1573	1574	1575	1576	1577	1578	1579	1580
1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	1496	1497	1498	1499	1500
1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420
1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340
1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180
1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100
1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020
921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940
841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860
761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780
681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620
521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540
441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

Fig. 2. (continued)

2541	2542	2543	2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560
2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480
2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400
2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320
2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240
2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160
2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080
1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
1821	1822	1823	1824	1825	1826	1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837	1838	1839	1840
1741	1742	1743	1744	1745	1746	1747	1748	1749	1750	1751	1752	1753	1754	1755	1756	1757	1758	1759	1760
1661	1662	1663	1664	1665	1666	1667	1668	1669	1670	1671	1672	1673	1674	1675	1676	1677	1678	1679	1680
1581	1582	1583	1584	1585	1586	1587	1588	1589	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1600
1501	1502	1503	1504	1505	1506	1507	1508	1509	1510	1511	1512	1513	1514	1515	1516	1517	1518	1519	1520
1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440
1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360
1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280
1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200
1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120
1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040
941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960
861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880
781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640
541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

Fig. 2. (concluded)

The grid cell identification number is the center point of the grid cell (polygon) and although it is not the physical location of each data variable within the cell, it links all data variables that are located within the grid cell.

One of the two supplemental data groups offers all 29 data variables (i.e., the 22 original and the 7 relative risk variables) used in this data base in their original line-based format. This data group is stored as an exported ARC/INFOTM line coverage and as a flat ASCII file. The data values in this data group may vary slightly from those in the gridded data groups, since more than one line segment often fell within a grid cell. The average length of the 2017 line segments within this group is approximately 7 km, and when plotted, equals those found in the auxiliary data group.

Nine of these 29 data variables were originally obtained as point data, and constitute the second supplemental data group. These data variables are stored in an exported ARC/INFOTM point coverage and as a flat ASCII file. Each data point within this group refers to the exact location where the measurement was taken (e.g., latitude-by-longitude location). Data variables within this group include: station name/number, latitude/longitude location, period of record, and the measurements used to derive the relative sea level trend, long-term geologic trend, corrected sea-level trend, local subsidence trend, mean tidal range, maximum tidal range, and mean-tide-level variables.

The final data group contains a 1:2,000,000 digitized coastline of the U.S. Gulf Coast extracted from a map originally digitized by the USGS. This auxiliary data group is provided for use with the gridded data group since it contains the U.S. Gulf Coast as defined by this NDP. These data are stored as an exported ARC/INFOTM line coverage and as a flat ASCII file.

7. Original Data Variables

The data sets that comprise this data base include the following: elevation, geology, geomorphology, sea level trends, horizontal shoreline displacement (erosion/accretion), tidal ranges, and wave heights. These data sets were obtained in a variety of scales and formats (e.g., as polygon, line, or point data). Therefore, the methods used to enter the data into the 0.25° grid cells and 1:2,000,000 digitized line segments vary by data set. The variable descriptions used in this data base were extracted from annual reports submitted in April 1988, November 1988, April 1991; and personal correspondence (Gornitz 1988a, 1988b, 1991; Gornitz and White 1992). The following subsections provide a brief description of the data sources and the classification methods used in compiling each data set.

7.1 Elevation

The elevation data for this data set were obtained from the NGDC in Boulder, Colorado, as digitized land elevations (to the nearest meter) for 5' latitude by 5' longitude grid cells. The NGDC grid contained: negative values for grid cells containing no land within their boundaries; 0 values for grid cells with land at sea level; and positive values for grid cells with land above sea level. The NGDC grid cells lying along the Gulf Coast were grouped into the 0.25° x 0.25° grid cells used in this data base. Minimum, mean, and maximum elevation data are provided for each 0.25° cell. Each 0.25° cell may contain as many as nine 5' grid cells. If only one 5' grid cell within a given 0.25° cell contains a positive or zero data value, then the minimum, mean, and maximum elevation variables will be identical. To calculate and transfer these data from 5' by 5' to the 0.25° grid used in this data base, the variables were calculated as follows:

- (1) The number of 5' NGDC grid cells with positive elevation values within each 0.25° grid cell was determined.
- (2) The minimum elevation was assigned by finding the minimum elevation of all non-negative 5' grid cells within each 0.25° grid cell.
- (3) The mean elevation was assigned by averaging of the elevations of all non-negative 5' grid cells within each 0.25° cell.
- (4) The maximum elevation was assigned by finding the maximum elevation of all 5' grid cells within each 0.25° grid cell.

To check these data for reasonableness, the 0.25° grid cells were overlaid onto a 1:2,000,000 digitized coastline map of the U.S. Gulf Coast. Through examination of this overlay, it was discovered that peninsulas and small islands often were not represented due to the low resolution of the NGDC grid cells (i.e., mean elevation values were rounded to the nearest whole number). To overcome this limitation, 0.25° grid cells containing barrier islands and other low-lying landforms were assumed to lie near mean sea level and were assigned a mean elevation of 0 m, as illustrated in Fig. 3.

Fig. 3. The original NGDC elevation data set and the corrected coastal grid cells with calculated mean elevation values (i.e., values of 0 m) used in this NDP.

A mean elevation value of 0 m indicates that the land within the grid cell is probably less than 1 m above sea level. Since 0 is also a real data measurement, grid cells with assigned mean elevations are denoted within this data base as having a 0 value for the number of NGDC grid cells variable. A limitation of this method is that even if only a small portion of land is located within the 0.25° grid cell, the entire grid cell contains a mean elevation value of 0 m.

Mean elevation values range from 0.0 m to 29.0 m along the Gulf Coast while the average mean elevation is near 2.0 m. Tectonic stability has resulted in relative small local relief along the Gulf Coast (i.e., more than 95% of the Gulf coastline lies at or below 10 m and is considered to be at high risk to erosion and/or sea-level rise).

7.2 Geology

The geology (lithology) variable identifies generalized rock type and is present for all coastal grid cells and line segments within the data base. The geology data were derived from state geologic maps ranging in scale from 1:250,000 to 1:1,000,000 with publication dates from 1924 to 1988 (maps used are listed in section 13.2). The geologic data were classified in terms of an ordinal scale based on the relative hardness of minerals comprising the rock. This geologic classification system was adapted in part from one used by Dolan et al. (1975). It contains 5 major groups further subdivided into 20 subgroups (Table 1).

Table 1. Geologic classification codes assigned to the coastal geology variable.

Material description		Code
I.	Old Erosion Resistant Rocks (crystallines)	100
	A. Igneous, volcanic (basalt, rhyolite, andesite, etc.)	110
	B. Igneous, plutonic (granite, granodiorite, etc.)	130
	C. Metamorphic (schists, gneisses, quartzite, serpentinite, etc.)	150
II.	Sedimentary Rocks	200
	A. Shale	210
	B. Siltstone	220
	C. Sandstone	230
	D. Conglomerate	240
	E. Limestone	250
	F. Eolianite (calcite-sand)	260
	G. Mixed or varied lithology	270
III.	Unconsolidated Sediments	300
	A. Mud, Clay	310
	B. Silt	320
	C. Sand	330
	D. Gravel, conglomerates	340
	E. Glacial till	345
	F. Glacial drift (fluvial-glacial)	350

Table 1. (concluded)

Material description		Code
G.	Calcareous sediment	360
H.	Mixed or varied lithology	370
IV.	Recent Volcanic Materials	400
A.	Lava	410
B.	Ash, Temphra	420
C.	Composite	430
V.	Coral reef	500

Appendix B contains a glossary of the terms used in Table 1. This ranking scheme is generalized; consequently, a wide range of erodibilities exist for each rock type listed. The erodibility of each rock depends upon the mineral content, cementation (especially for sedimentary rocks), grain size (for unconsolidated sediments), and presence of planar elements (i.e., bedding, schistosity, cleavage, and fractures) within the rock. The key discriminant between the individual classes identified in Table 1 is the relative resistance of each rock type to physical and chemical weathering.

The geology data were assembled as follows:

- (1) Enlarged maps of the 1:2,000,000 digitized U.S. Gulf Coastline included in this NDP were plotted in small sections (i.e., approximately 5° latitude by 5° longitude on 3 ft² paper).
- (2) Polygons (boxes) were drawn around each coastal segment as identified by the state geologic maps listed in Section 13.2.
- (3) The hand-drawn polygons were digitized into ARC/INFO™ using the 1:2,000,000 digitized U.S. Gulf Coastline coverage included in this NDP as a backdrop.
- (4) These polygons were then overlaid onto the backdrop coverage with the ARC/INFO™ IDENTITY command whereby the coastal segments took on the values of the digitized polygons.
- (5) For the gridded data groups, a 0.25° latitude by 0.25° longitude grid was overlain onto the 1:2,000,000 digitized line coverage using an additional ARC/INFO™ IDENTITY command. The grid cells then took on the geology values of the line segments.

Fig. 4. Example of how the geologic data were transferred from the 1:2,000,000 digitized coastal outline maps to the 0.25° by 0.25° grid cells used in this data base.

As illustrated in Fig. 4, if more than rock type occurred within a grid cell, the geology code with the greatest coastal length was assigned to the entire grid cell. For example, if the bedrock geology of a given 0.25° grid cell contained silt (320), sand (330), and limestone (250) in the percentages 35%:40%:25%, respectively, then the geologic code assigned to the grid cell would be 330 (i.e., sand). Appendix C gives a breakdown of the geology codes that occurred within each 0.25° by 0.25° coastal grid cell. The geology codes listed in Appendix C are identical to those found in the line segment-based data groups within this NDP.

In general the bedrock geology of the Gulf Coast consists of limestones and sandstones overlain by unconsolidated sediments from alluvial sources and may be further divided into nine geologic regions. From east to west these regions are the South Florida Basin, Ocala Arch, Appalachicola and Mississippi Basins, Monroe and Sabine Arches, East Texas Basin, San Marcos Arch, and Rio Grande Basin (Graf, 1987). The basins tend to be regions of subsidence, since the unconsolidated sediments within them are compacted by the addition of new sediments. The arches tend to be regions of relative uplift.

7.3 Geomorphology

Geomorphology data are provided for all coastal grid cells in the data base. The data values were interpreted and classified from USGS 1:250,000 topographic maps (maps used are listed in section 13.3) and other published sources, such as Shepard and Wanless (1971) and Bird and Schwartz (1985). The landforms identified from the 1:250,000 maps may omit landforms with small spatial extent. The maps used for the Gulf Coast were compiled from 1966 (for Corpus Christi, Texas) to 1988 (for St. Petersburg, Florida).

The classification system used divides the Gulf Coast into two major groups, those formed by erosion and those formed by deposition (Table 2). These two groups are further subdivided into several categories (e.g., marine, nonmarine, glacial, nonglacial, and volcanic). Appendix B contains a glossary of the terms used to describe each landform type. Appendix C gives a breakdown of the geomorphic codes found within each cell, and each line segment is identical to those found in the line segment based data group. Several geomorphic features can occur in more than one coastal environment. Therefore, a fourth digit was added to the three-digit feature identification code. This last digit identifies areas such as marshes, beaches, or areas that have been significantly modified by human activities, which may occur in a number of different geomorphic settings. Thus each geomorphological class is uniquely identified by a four-digit code.

Table 2. Geomorphology classification codes assigned to the coastal geomorphology variable.

Landform description	Code	Beach	Man modified
I. Erosional coasts (scoured, beaches poorly developed)	1000		
A. Marine with wave erosion and cliffs	1100		
1. Low (5-30 m)	1110	1111	1119
2. Medium (30-100 m)	1120	1121	1129
3. High (> 100 m)	1130	1131	1139
B. Nonmarine (land erosion)	1200-1500		
1. Glaciated coast	1210	1211	1219
a. Fjord (drowned valley)	1220	1221	1229
b. Indented fiard (low-lying inlet)	1230	1231	1239
mud flats	1234		
salt marsh	1235		
c. Rocky glacial coast	1240	1241	1249
salt marsh	1245		
2. Nonglacial irregular coast	1300		
a. Strongly embayed, nonrocky	1310	1311	1319
b. Strongly embayed, rocky	1320	1321	1329
c. Estuaries	1330	1331	1339
mud flats	1334		
salt marsh	1335		
mixed types	1338		
3. Ice coasts	1400		
4. Drowned karst topography	1500		
II. Depositional coasts (sediment accumulations and well-developed beaches)	2000		
A. Marine deposit	2100		
1. Coastal plain beach	2110	2111	2119
salt marsh	2115		
2. Beach rock (beach sediment cemented by carbonates)	2112		

Table 2. (continued).

Landform description	Code	Beach	Man modified
3. Barrier coast	2120	2121	2129
a. barrier island	2122		
b. bay barrier	2123		
c. mud flats	2124		
d. salt marsh	2125		
e. cusplate foreland	2126		
f. spit	2127		
g. mixed	2128		
B. River deposits	2200		
1. Alluvial plain	2210	2211	2219
2. Delta environment	2220	2221	2229
a. mud flats	2224		
b. salt marsh	2225		
c. mixed	2228		
C. Marine/fluvial deposits (Lagoonal coast)	2250	2251	2259
1. Mud flats	2254		
2. Marsh/mangrove	2255		
3. Mixed	2258		
D. Glacial deposits			2300
1. Outwash plain	2310	2311	2319
2. Moraine	2320	2321	2329
3. Drumlin	2330	2331	2339
salt marsh	2315		
4. Drift	2340	2341	2349
salt marsh	2345		
5. Composite	2350	2351	2359
E. Biogenic	2400		
1. Reefs (coral, oysters, algal)			
a. fringing	2410	2411	
b. barrier	2420	2421	2429
2. Barrier reef with an associated mangrove swamp	2425		
3. Swamp/mangrove	2450	2451	2459
F. Volcanic coasts	2500		
1. Lava flows	2510	2511	2519
2. Tephra, ash	2520	2521	2529
3. Composite/caldera	2530	2531	2539

Based on Table 2, all grid cells that lay on the Gulf Coast have been assigned a data value which is the code with the maximum shore length within each cell. The geomorphology data were

compiled using the same procedures described earlier for the geology data (see Sec. 7.2, pages 14–15). Appendix C gives a breakdown of the geomorphology codes that occurred within each grid cell and is identical to the line segments data found in the line based-data groups within this NDP.

Fig. 5 illustrates how the geomorphology data were transferred to the 0.25° latitude by 0.25° longitude grid cell used in this data base.

Fig. 5. Example of how geomorphic data codes were transferred to the 0.25° grid cells used in this data base.

In general the geomorphology data indicate the presence of unconsolidated sediments and unstable landforms. The entire Gulf coastline falls into risk classes 3, 4, and 5 (i.e., moderate, 54%; high, 19%; and very high, 26%) and is considered to be susceptible to erosion and/or sea-level rise.

7.4 Sea-Level Trends

The sea level trend data for the U.S. Gulf Coast was derived from 12 tide-gauge stations (Pugh et al., 1987). The sea-level trends used in this data base were measured in mm/year and have a minimum of 20 years of record (records may however contain discontinuities). The following variables were derived from the tide-gauge records: a relative sea-level trend variable, a global-trend variable, a corrected sea-level trend variable, a local subsidence variable, and a variable containing the number of years of record used in estimating these values.

The relative sea-level trend was calculated using a linear least-squares regression line fitted to the time-series of mean annual sea level elevations for each of the 12 long-term tide gauge stations (Lyles, et al. 1987; Emery and Aubrey, 1991). To interpolate a relative sea-level-trend variable for those segments of the Gulf coastline lying between tide-gauge stations, the following steps were taken:

- (1) The tide-gauge stations and the sea-level trends were plotted along a 1:2,000,000 digitized U.S. Gulf coastline.
- (2) The 0.25° by 0.25° grid used in this NDP was then overlaid onto the tide-gauge stations with an ARC/INFOTM IDENTITY command, whereby the grid cells were assigned sea level trends from the tide-gauge stations lying within the cells.
- (3) For each coastal grid cell without data, the difference in relative sea levels was calculated between the two nearest gauge stations (i.e., occurring east and west or north and south of the given grid cell).
- (4) The difference between the relative sea levels was then divided by the number of grid rows, plus one, occurring between the grid cells containing gauge stations. This value was called the slope factor.
- (5) The slope factor was then multiplied by the number of grid rows from the grid cell being calculated to the nearest station (i.e., western-most or southern-most station) and added to the station's relative sea-level trend.

These steps are illustrated in Fig. 6. It should be noted that tide gauges measure sea level variations in relation to a fixed benchmark and are therefore relative due to vertical land movements and to real changes in ocean levels.

Fig. 6. Location of the 12 tide-gauge stations and example of how station values were aggregated along the Gulf coastline.

The procedure for calculating the subsidence factor along the U.S. Gulf Coast differs from that used for U.S. East Coast (Gornitz and Lebedeff 1987; Gornitz and White 1992). Along the East Coast, Holocene paleosealevel indicators were used to calculate a long-term geologic trend variable (Gornitz and Seeber, 1990). The geologic trend variable was then subtracted from the relative sea-level-trend variable to yield a subsidence factor for each 0.25° coastal grid cell. Holocene paleosealevel indicators are not available for the Gulf Coast. Hence, the geologic trend variable within this data base contains only 0 data values. This variable is included in this data base to promote compatibility within this series of NDPs (i.e., NDP-043A, NDP-043B, and NDP-043C). The subsidence factor for the U.S. Gulf Coast was calculated by assuming the global eustatic rate of sea level rise to be 1.5 mm per year, as reported by the International Panel on Climate Change (IPCC), (Houghton et al., 1990), and subtracting this rate (i.e., 1.5 mm/yr) from the relative sea-level trend variable. The resultant difference is the subsidence factor for each 0.25° coastal grid cell and line segment along the Gulf Coast.

The local subsidence variable gives an indication of the relative vulnerability of each coastal grid cell and line segment to sea-level rise. This variable may be used to identify areas that are subsiding faster or slower than the regional averages. It is also added to any future projected global sea level curves, to adjust the global curve to local conditions.

7.5 Horizontal Shoreline Displacement (Erosion/Accretion)

The erosion/accretion data used in the development of the horizontal shoreline displacement data set were extracted and modified from the Coastal Erosion Information System (CEIS) developed by May et al. (1982, 1983) and Dolan et al. (1975, 1983, 1989)^a. The CEIS data are limited in extent to coastlines that open into the ocean or large bays. The displacement data within the CEIS data base were originally obtained from over 500 individuals or organizations with records ranging in length from 20-165 years. The majority of the shoreline displacement measurements, however, were made from historic maps and aerial photographs that cover the U.S. Gulf Coast for a minimum of 40 to 50 years. Most of the information was originally obtained from published reports or from regionally available high-resolution data sets (e.g., Dolan et al. 1980). Of the data within CEIS, 25% were obtained in raw form and converted into point measurements of erosion or accretion. In conducting the measurement and data compilation steps of the raw data, May et al. (1982) used the landward limit of wetted sand as the criteria for identifying the shoreline. This definition was selected because it produced the most consistent results in the photo-interpretation process.

By comparing present and past shorelines from maps, aerial photographs, and data from regional studies, May et al. (1982) were able to obtain rates of change, expressed in m/year, for coastal points on the Gulf. May et al. (1982) then averaged and extrapolated the point data into 3' latitude x 3' longitude grid cells (in locations with sparse data 7.5' and 15' grid cells were used) to minimize the problems associated with mapping errors, imprecise shoreline definitions, and poor temporal resolution within the original erosion/accretion data sources. These 3', 7.5', or 15' grid cells were then overlaid into the 0.25° grid cells used in this data base to derive the following data variables (values in m/year): minimum erosion trend, mean erosion trend, maximum erosion trend, and the number of 3', 7.5', or 15' cells used in deriving the data for each 0.25°

^aPortions of the CEIS data base used in this NDP are currently being updated by Dolan and others for the USGS. Partial documentation of these changes may be found in Dolan et al. (1990) and Dolan et al. (1991).

grid cell. To transfer this information to the 0.25° grid cells used in this data set, the erosion variables were recalculated as follows:

- (1) The number of 3', 7.5', or 15' grid cells that occur in a given 0.25° grid cell was determined. These 3', 7.5', or 15' cells were used to calculate the minimum, mean, or maximum erosion rate variables.
- (2) The minimum erosion rate for a 0.25° grid cell is the minimum erosion rate found in the 3', 7.5', or 15' grid cells within a 0.25° grid cell.
- (3) The mean erosion rate for a 0.25° grid cell is the average of the erosion rates of all 3', 7.5', or 15' grid cells within a 0.25° grid cell.
- (4) The maximum erosion rate for a 0.25° grid cell is the maximum erosion rate found in the 3', 7.5', or 15' grid cells within a 0.25° grid cell.

Fig. 7 gives an example of how the overlay process was used to transfer the data values from the 3', 7.5', or 15' grid cells to the 0.25° grid.

Fig. 7. Example of how the shoreline displacement data were transferred to the 0.25° grid cells used in this NDP.

The gridded data were then overlaid onto a 1:2,000,000 digitized U.S. Gulf Coastline to form the line segment version of these data found in the supplemental line segment data group (GCLINE).

Based on the length of record, from 20 to 165 years depending on location, and the errors inherent in the data, the reported shoreline displacement trends are average values that are highly variable over time; as such, rates of change less than ± 0.6 m/year are not considered significant. The CEIS data base, however, does indicate that the general pattern of shoreline displacement on the U.S. Gulf Coast is one of erosion.

Areas experiencing significant erosion, with rates greater than 8 to 10 m/yr, occur on the Louisiana barrier islands. Other areas with high erosion rates include the coasts northeast of Galveston Bay; southwest of Freeport, Texas; and South Padre Island, Texas.

7.6 Tidal Ranges

The tidal range data set was obtained from tide tables published by NOAA's National Ocean Service (NOS) for 187 stations located on the Gulf Coast (NOS, 1992). These station data were entered into the ARC/INFOTM GIS as point data and are available in the supplemental data group. The supplemental data group contains the name, identification number, longitude/latitude, mean tidal range, maximum tidal range, and mean tide level for each tide-range station. The data for each station were overlaid onto the 0.25° grid cells used in this data set, and the variables calculated based on the stations that fell within each grid cell (values expressed in meters) as follows:

- (1) The number of tide stations that fell within each 0.25° grid cell was calculated. The stations within each cell were then used to derive the mean tide level, and the mean and maximum tidal ranges for each 0.25° grid cell.
- (2) The mean tidal range for each grid cell is the average of the diurnal tidal ranges of all the stations within a given cell.
- (3) The maximum tide range for each grid cell is the largest value found within the diurnal tide ranges of all the stations within a given cell.
- (4) The mean tide level for each grid cell is the average of the mean tide levels of all the stations within a given cell.

Fig. 8 gives an example of how this conversion from point data to area data was conducted for the maximum tide-range variable. The gridded data were overlain onto a 1:2,000,000 digitized U.S. Gulf Coastline to form the line segment version of these data found in the supplemental line segment data group.

The mean tidal range at a given tide station in this data set is defined as the difference in height between mean high water and mean low water in 1988. Tide heights vary annually, but their differences are *relatively* constant in relation to one another. The maximum tide range variable contains the "diurnal tide range." The diurnal tide range is defined as the difference in height between mean higher high water and mean lower low water (NOS, 1992). The mean tide level variable is defined as a plane midway between mean low water and mean high water in 1988. This value is reckoned from chart datums. The chart datums used in the tide tables for the mean tide level variable is the Gulf Coast Low Water Datum.

The magnitude of the tidal range variables defined above has been linked to both inundation and erosion hazards. Although a large tidal range dissipates wave energy, it also delineates a broad

zone of low-lying intertidal wetlands susceptible to inundation. Furthermore, the velocity of tidal currents in estuaries depends on the tide range, as well as the asymmetry of the tidal cycle and channel morphology. Therefore, when holding these other factors constant, high-tide ranges are associated with stronger tidal currents capable of eroding and transporting sediment offshore. Tidal ranges average less than 2 m/yr on the Gulf Coast with slightly higher values occurring in parts of the Everglades.

Fig. 8. Example of how tide-gauge data were transferred to the 0.25° grid cells for the maximum tide range variable.

7.7 Wave Heights

This wave-height data set contains three data variables (all variables expressed in meters): the maximum significant wave height, the 20-year mean wave height, and the standard deviation of the mean). This data set was originally obtained from published documents of the Coastal Engineering Research Center (CERC), U.S. Army Corps of Engineers, *Wave Information Study (WIS)*. In the study CERC calculated wind speeds from station histories, National Weather Service surface charts, surface pressure data, ships-at-sea observations, and monthly air-sea temperature gradients, in a 3 phase process. Phase 1 hindcasted wind speeds/directions for each 120 nautical-mile-long segment while Phase 2 hindcasted wind speeds for a 30 nautical-mile spacing. In Phase 3, wind data were input into a transformation model that hindcasted nearshore wave heights for each 10 nautical-mile-segment (CERC, 1971). Phase 3 and a WIS shallow water wave model were used for the Gulf Coast (Hubertz et al., 1989) to derive 0.5° gridded wave heights. The wave heights forecast within the WIS are for the open coast and large bays. As such, most intracoastal areas including many lagoons within the data source were missing data.

The ARC/INFO™ UNION command was used to determine the geometric intersection of the 52 WIS 0.5° grid cells with the 0.25° grid used in this NDP using and resulted in the creation of 208 0.25° grid cells. The WIS data variables (i.e., maximum significant wave height, 20-year mean wave height, and the standard deviation of the mean) were also transferred to 208 0.25° grid cells during this process.

Fig. 9. Example of how the wave-height data were transferred to the 0.25° grid cells used in this NDP.

8. Relative Risk Factors

The previous section discussed how the original 22 data variables within this data base were obtained and entered into the GIS [i.e., as polygons for elevation, geology, geomorphology, shoreline displacement (erosion/accretion), and wave heights; as points for sea level trends and tidal ranges; or as lines for the 1:2,000,000 digitized U.S. Gulf Coastline]. These data were directly digitized from maps or copied from computer tapes and imported into the ARC/INFO™ GIS, where the information was analyzed and the data values were incorporated into the 0.25° grid cells and 1:2,000,000 digitized line segments. The entry of these data into common formats (i.e., 0.25° grid cells and 1:2,000,000 digitized line segments) has made it possible to relate and manipulate the data to identify relationships among the different variables.

A vulnerable coastline is characterized by low coastal relief, an erodible subsidence, extensive shore line retreat, and high wave/tide energies (Gornitz et. al. 1991). To simplify the manipulation process, seven of the original data variables were classified into seven new "risk" variables. Each risk variable ranges in value from 1 to 5 and indicates the cell's relative risk to erosion or inundation. The risk assignments for mean elevation, mean shoreline displacement, local subsidence trend, mean tidal range, and maximum significant wave height (i.e., the numeric data variables) are given in Table 3. The risk assignments for geology and geomorphology (i.e., the nominal data) are given in Tables 4 and 5, respectively. These risk assignments are discussed in greater detail by Gornitz et. al. (1991).

Table 3. Assignment of relative risk factors for elevation, shoreline displacement, local subsidence trend, tidal range, and wave height.

Variable:	Very low 1	Low 2	Moderate 3	High 4	Very high 5
Mean elevation (m)	> 30	> 20 and ≤ 30	> 10 and ≤ 20	> 5 and ≤ 10	> 0 and ≤ 5
Mean shoreline displacement (m/year)	> 2.0 Accretion	> 1 and ≤ 2	> -1 and ≤ +1	> -2 and ≤ -1	≤ -2 Erosion
Local subsidence trend (mm/year)	< -1 Land rising	≥ -1 and ≤ 1	> 1 and ≤ 2	> 2 and ≤ 4	> 4.0 Land sinking
Mean tidal range (m)	< 1.0 Microtidal	≥ 1 and < 2	≥ 2 and ≤ 4	> 4 and ≤ 6	> 6.0 Macrotidal
Maximum significant wave height (m)	≥ 0 and < 3	≥ 3 and < 5	≥ 5 and < 6	≥ 6 and < 6.9	≥ 6.9

Table 4. Assignment of relative risk factors for geology.

Rank	Geology values ^a
1	100, 110, 130, 410
2	150
3	200, 210, 220, 230, 240, 250, 260, 270, 400, 430, 500
4	300, 340, 345, 370
5	310, 320, 330, 350, 360, 420

^a See Table 1 for description of geology values.

Table 5. Assignment of relative risk factors for geomorphology.

Rank	Geomorphology values ^b
1	1130, 1139, 1210, 1219, 1220, 1229, 1230, 1239, 1240, 1249, 1320, 1329, 2510, 2519
2	1120, 1129, 1131, 1211, 1221, 1231, 1234, 1235, 1241, 1245, 1310, 1319, 2511
3	1110, 1119, 1121, 1311, 1321, 1335, 1338, 2112, 2115, 2125, 2225, 2255, 2300, 2315, 2320, 2329, 2330, 2339, 2340, 2345, 2349, 2350, 2359, 2400, 2410, 2419, 2420, 2425, 2429, 2450, 2459, 2500, 2530, 2539
4	1111, 1330, 1339, 2200, 2210, 2219, 2228, 2250, 2258, 2259, 2310, 2319, 2321, 2331, 2341, 2351, 2411, 2421, 2451, 2520, 2529
5	1331, 1334, 2110, 2111, 2119, 2120, 2121, 2122, 2123, 2124, 2126, 2127, 2128, 2129, 2211, 2220, 2221, 2224, 2229, 2251, 2254, 2311, 2521, 2531

^b See Table 2 for a description of geomorphology values.

9. The Coastal Vulnerability Index

The seven relative risk variables contained within this data base may be used to formulate a coastal vulnerability index. This index may be used to identify areas that are at risk of erosion and permanent or temporary inundation. Grid cells and/or line segments with high index values will tend to have low reliefs, erodible substrates, histories of subsidence and shoreline retreat, and high wave and tide energies (Gornitz et al., 1991). However, when several risk factors for a given area are missing data, then any calculated index will underestimate the risk faced by the area in question.

The following methods for deriving such an index have been tested on a sample of 93 randomly selected coastal segments and seem to be adequate for the task when the number of risk factors that are missing data, for a given location, is less than three. The addition of new variables to this data base or the use of a different classification system for the risk variables may result in index values that differ significantly from those that would be produced using the formulas below. These six formulas were proposed and tested for the derivation of a Coastal Vulnerability Index (CVI) by Gornitz et al. (1991), while CVI₅ was used in Gornitz and White (1991), Gornitz et al. (1991), and Gornitz (1990, 1991).

Product mean:
$$CVI_1 = \frac{(x_1 * x_2 * x_3 * x_4 * \dots x_n)}{n}$$

Modified product mean:
$$CVI_2 = \frac{[x_1 * x_2 * \frac{1}{2}(x_3 + x_4) * x_5 * \frac{1}{2}(x_6 + x_7)]}{n - 2}$$

Average sum of squares:
$$CVI_3 = \frac{(x_1^2 * x_2^2 * x_3^2 * x_4^2 * \dots x_n^2)}{n}$$

Modified product mean (2):
$$CVI_4 = \frac{(x_1 * x_2 * x_3 * x_4 * \dots x_n)}{5^{(n-4)}}$$

Square root of product mean:
$$CVI_5 = [CVI_1]^{1/4}, \quad \text{and}$$

Sum of products:
$$CVI_6 = 4x_1 + 4x_2 + 2(x_3 + x_4) + 4x_5 + 2(x_6 + x_7).$$

Where:

n = variables present	x ₁ = mean elevation
x ₂ = local subsidence trend	x ₃ = geology
x ₄ = geomorphology	x ₅ = mean shoreline displacement
x ₆ = maximum wave height	x ₇ = mean tidal range.

The relative risk variables were assigned to one of five classes on the basis of Tables 5, 6, and 7. Errors in the classification of any of the variables could result in a misclassification of up to one risk class for each risk variable. The sensitivity of each of the six CVI formulas to misclassification errors was tested by changing the relative risk factor of 1 to 3 risk variables from high to low (i.e., 5 to 1) while holding the others fixed at a value of 5. The calculated sensitivity is the percentage change from the original CVI (with all variables set to five), such that the greater the value the greater the percent change. Table 6 illustrates that for some CVIs, a change in two or more variables may result in more than one score. When this occurs only the maximum value is shown, Gornitz (1991).

Table 6. Sensitivity of different Coastal Vulnerability Indices to changes in risk class from high to low assignments for one to three variables.

	Number of Variables Changed		
	1	2	3
CVI			
CVI ₁	80	96	99
CVI ₂	80	96	99
CVI ₃	14	27	41
CVI ₄	80	96	99
CVI ₅	56	80	81
CVI ₆	16	32	48

This table indicates that CVI₁, CVI₂, and CVI₄ are highly sensitive to variations in the classification of the risk variables, whereas CVI₃ is insensitive to classification variations. CVI₅ seems to be relatively insensitive to variations in one risk factor, while still being able to produce usable results when differences occur within several factors. CVI₆ minimized the effects of variations in one variable (in the relative risk classification system) while still being sensitive to significant differences in risk factor values. Thus, in future studies CVI₆ may be preferable to CVI₅.

A histogram of the data values from CVI₅ was constructed and three classes were developed (i.e., low-, moderate-, and high-risk). Grid cells and/or line segments at "high risk" to coastal erosion or sea level rise are defined as having an index value > 22; moderate-risk 16 to 22; and low-risk < 16. An example of how the CVI₅ may be used to identify high-risk coastlines is shown in Fig. 10.

Fig. 10. Example of how the Coastal Vulnerability Index may be used to identify high-risk coastlines near the Alabama and Louisiana border.

CVI₂ values range from 2.12 to 40.09 along the Gulf Coast, while the mean value is 15.83. The areas at highest risk to erosion and/or sea-level-rise are the barrier islands, particularly those in Texas and Louisiana. The coastal state boundaries of Louisiana also have high CVI values. Most of the Gulf portion of Florida falls within the moderate risk class, whereas many high risk areas occurred on the East Coast of Florida. This difference is due in part to the lower energies of wave heights and tidal ranges on the Gulf Coast.

10. Limitations and Restrictions of the Data

Because of the spatial extent of this data base the period of record, sampling frequency, and scale of the source documents varied. The use of long-term averages and the choice of the 0.25° grid cell as the spatial scale for these data has minimized the error that may have been introduced into this data base when these data sources were integrated into a single data base with uniform formats and scales.

The geologic data were classified in terms of an ordinal scale based on the relative hardness of minerals comprising the rock, and derived from state geologic maps. Since these characteristics cannot be deduced from the geologic maps alone, field checking would be required to obtain a more detailed classification than that used in this data set.

The sea-level trend variables (derived from long-term tide-gauge records) may have significant error due to the interpolation methods used. The tide-gauge records used for calculating the sea level trends on the Gulf Coast were obtained from the records of the *Permanent Service for Mean Sea Level* (Pugh et al. 1987). These records have been examined and contain no identifiable errors, are of very high quality, and have been used in several sea-level-rise studies (Douglas 1991). The sparse station network, however, has made it necessary to calculate the sea level trend variables for intervening grid cells by calculating a slope line between the two closest adjacent stations. Confidence in the accuracy of the local subsidence variable and the relative and corrected sea-level-trend variables estimated with this method decreases as the distance between grid cells that are missing data and adjacent tide-gauge stations increases. If the distance from a grid cell with no-data to the nearest two long-term gauge stations (i.e., that are East and West or North and South of the no-data grid cell) exceeds ~350 km (i.e., at that distance the r^2 of adjacent stations is 0.717), then the sea-level-trend variable derived for the no-data grid cell may be erroneous.

The statistical summations given within this NDP reflect 0.25° latitude by 0.25° longitude gridded data values and may vary slightly from those given in publications by the contributors. Some of these differences are due to differences in the resolution of the 1:2,000,000 digitized line coverages (e.g., the base coastal map in this NDP is 14,256 km in length while the base coastal map used by Gornitz et al. 1991, 1992 and 1994 was 14,356 km in length). Another discrepancy is that the tide tables used in this document are for 1992 (NOS 1992) where as those used by Gornitz and others were for 1988 (NOS 1988).

The coastal hazards data base presented here for the U.S. Gulf Coast omits several factors that may be important when determining the risk of a given area to inundation or erosion. Other variables that may be useful in the risk assessment process are: storm surge, storm frequencies, storm intensities, presence of exposed infrastructure, coastal population density, the role of sediment transport, and the risk of saltwater intrusion (Titus et al. 1991; Snedaker and Sylva 1987). Several pilot studies have been done that consider several of these factors. Gornitz et al. (1993) conducted a pilot study with an expanded CVI based on the seven relative risk variables in this NDP and six climatic factors derived from Birdwell and Daniels (1991). Another study, Daniels et al. (1992) used CVI, and this data base to identify high-risk shorelines in the U.S. Southeast, whereby further studies were conducted. A copy of this report can also be obtained from CDIAC.

11. Data Checks Performed by CDIAC

An important part of the data packaging process at the CDIAC is the quality assurance (QA) of the data before its distribution. Data received at CDIAC are rarely in perfect condition for immediate distribution, regardless of source. CDIAC staff members examine the data for completeness, reasonableness, and accuracy. The QA process is an important component in the value-added concept of assuring accurate, usable information for researchers. The following summarizes the QA checks performed on the various data groups presented in this document:

- (1) Data variables obtained from primary data sources were double-entered from into flat ASCII files and proofed for discrepancies. The generated machine-readable data files were then uploaded to a Sun workstation and read into SASTM. The SASTM "COMPARE" utility was used to overlay the two versions and identify differences. All differences identified using this SASTM utility were then checked against the ordinal data source, and any necessary corrections made.
- (2) Data variables obtained from maps (e.g., geology) were classified and transferred to coastal segments on working maps of the coastline. The working maps were then digitized, plotted, and compared with the original working maps and data sources. All identified discrepancies were then corrected.
- (3) Maximum, minimum, and mean values were generated for all data variables and checked for reasonableness against predetermined thresholds.
- (4) The data values for each data variable were mapped using the 1:2,000,000 digitized USGS line-segment coverage of the U.S. Gulf Coast as a backdrop to check for outliers and identifiable discrepancies. The identified data items were then recalculated, and corrected if necessary.

12. How to Obtain the Package

This document describes the contents of a coastal hazards data base intended for use by vector or raster GISs or non-GIS data bases. The computerized data are available on 9-track magnetic tapes, Exabyte 8mm tapes, QIC quarter-inch tape cartridges, or IBM DOS-compatible floppy diskettes (high density, 3.5- or 5.25-inch), and through File Transfer Protocol (FTP) from CDIAC. Requests for magnetic tapes should include any specific instructions for transmitting the data as required by the user to access the data. Requests not accompanied by specific instructions will be filled on 3½" high density diskettes with data written in ASCII format. Requests for this data package should be addressed to:

Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
Post Office Box 2008
Oak Ridge, Tennessee 37831-6335, U.S.A.

The media and/or documentation can be ordered by telephone, fax or electronic mail using:

Telephone: (615) 574-0390 or (615) 574-3645; FAX: (615) 574-2232
BITNET: CDP@ORNLSTC; INTERNET: CDP@STC10.CTD.ORNL.GOV; OMNET: CDIAC

The computerized data files may be acquired via INTERNET from CDIAC's Anonymous FTP service as follows:

- FTP to CDIAC.ESD.ORNL.GOV (i.e., "ftp CDIAC.ESD.ORNL.GOV. or ftp 128.219.24.36").
- Enter "ftp" as the User-ID (i.e., "ftp").
- Enter your electronic mail address as the password (e.g., BIRDK@ORNL.GOV).
- Change to the directory pub/ndp043b (i.e., "cd pub/ndp043b").
- Set FTP to ASCII mode by using the ASCII command (i.e., "ascii").
- Acquire the ASCII data files (i.e., "mget *.asc").
- Acquire the SAS™ files (i.e., "mget *.sas").
- Acquire the FORTRAN files (i.e., "mget *.for").
- Set FTP to Binary mode by using the Binary command (i.e., "binary").
- Acquire the binary ARC/INFO™ export files (i.e., "mget *.e00").
- Exit the system by using the FTP quit command (i.e., "quit").

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- U.S. Geological Survey. 1974. Brownsville, Texas. 1:250,000 series (topographic), Reston, Virginia.
- U.S. Geological Survey. 1982. Brownsville, Texas, Gulf Coast. 1:250,000 series (topographic), Reston, Virginia.
- U.S. Geological Survey. 19 . Charlotte Harbor, Florida. 1:250,000 series (topographic), Reston, Virginia.
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- U.S. Geological Survey. 1979. New Orleans, Louisiana. 1:250,000 series (topographic-bathymetric), Reston, Virginia.
- U.S. Geological Survey. 1970. Pensacola, Florida. 1:250,000 series (topographic), Reston, Virginia.
- U.S. Geological Survey. 1982. Pensacola, Florida, Gulf Coast. 1:250,000 series (topographic), Reston, Virginia.
- U.S. Geological Survey. 1978. Port Arthur, Texas. 1:250,000 series (topographic-bathymetric), Reston, Virginia.
- U.S. Geological Survey. 1982. Port Arthur, Texas, Gulf Coast. 1:250,000 series (topographic-bathymetric), Reston, Virginia.
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- U.S. Geological Survey. 1965. Valdosta, Georgia. 1:250,000 series (topographic), Reston, Virginia.
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- U.S. Geological Survey. 1982. West Palm Beach, Florida, Gulf Coast. 1:250,000 series (topographic-bathymetric), Reston, Virginia.

PART 2
INFORMATION ABOUT THE COMPUTERIZED DATA FILES

14. Contents of the Computerized Data Files

The following table lists the 21 data files distributed by the Carbon Dioxide Information Analysis Center (CDIAC) along with this documentation. These files are available on 9-track magnetic tapes, 8mm tapes, quarter inch tape cartridges, IBM-formatted floppy diskettes, and through internet using the File Transfer Protocol (FTP) from CDIAC's anonymous FTP area.

Table 7. Files and attributes provided on 9-track magnetic tape¹.

File number, description, and name	Logical records	Block size	Record length	File Size (MB)
1. General descriptive information file (NDP-043B.DOC)	927	8000	80	0.045
2. FORTRAN retrieval program to read and print file 5 (GCGRID.FOR)	50	8000	80	0.002
3. SAS TM code to read and print file 5 (GCGRID.SAS)	11	8000	80	0.001
4. Gridded data for the 22 original data variables, all 7 data sets (ARC/INFO TM export file, GCGRID.E00)	2561	8000	80	2.042
5. Gridded data for the 22 original data variables, all 7 data sets (flat ASCII file, GCGRID.ASC)	5120	8000	80	0.512
6. FORTRAN retrieval program to read and print file 9 (GCRISK.FOR)	36	8000	80	0.001
7. SAS TM code to read and print file 9 (GCRISK.SAS)	7	8000	80	0.001
8. Gridded data for the 7 relative risk variables: elevation, geology geomorphology, sea-level trends, erosion/accretion rates, tidal ranges, and wave heights (ARC/INFO TM export file, GCRISK.E00)	14397	8000	80	1.165

Table 7. (continued)

File number, description, and name	Logical records	Block size	Record length	File Size (MB)
9. Gridded data for the 7 relative risk variables: elevation, geology, geomorphology, sea-level trends, erosion/accretion rates, tidal ranges, and wave heights (flat ASCII file, GCRISK.ASC)	2560	3300	33	0.205
10. FORTRAN retrieval program to read and print file 13 (GCLINE.FOR)	56	8000	80	0.002
11. SAS TM code to read and print file 13 (GCLINE.SAS)	12	8000	80	0.001
12. 1:2,000,000 digitized line segment data for the 22 original variables and 7 relative risk variables. (ARC/INFO TM export file, GCLINE.E00)	16504	8000	80	1.335
13. 1:2,000,000 digitized line segment data for the 22 original variables and 7 relative risk variables. (flat ASCII file, GCLINE.ASC)	4034	8000	80	0.403
14. FORTRAN retrieval program to read and print file 17 (GCPOINT.FOR)	48	8000	80	0.002
15. SAS TM code to read and print File 17 (GCPOINT.SAS)	10	8000	80	0.001
16. Supplemental point data for the sea-level and tidal range data sets (ARC/INFO TM export file, GCPOINT.E00)	798	8000	80	0.065
17. Supplemental point data for the sea-level and tidal range data sets (flat ASCII file, GCPOINT.ASC)	398	8100	81	0.040

Table 7. (concluded).

File number, description, and name	Logical records	Block size	Record length	File Size (MB)
18. FORTRAN retrieval program to read and print File 21 (GCOAST.FOR)	51	8000	80	0.002
19. SAS TM code to read and print file 21 (GCOAST.SAS)	15	8000	80	0.001
20. 1:2,000,000digitized line segment coverage of the U.S. Gulf Coast (ARC/INFO TM export file, GCOAST.E00)	8446	8000	80	0.683
21. 1:2,000,000digitized line segment coverage of the U.S. Gulf Coast (flat ASCII file, GCOAST.ASC)	<u>307017</u>	2000	20	<u>0.614</u>
Total records and size	363,058			7.123

1. Tapes are 9-track, 6250 BPI, standard-labeled, with all characters written in ASCII unless otherwise specified by the requester.
2. All records are stored in a fixed-block record format.
3. ARC/INFOTM export files (Version 6.0.1) are coverages converted to flat ASCII, fixed-block, files for data transfer purposes. The IMPORT command in ARC/INFOTM must be used to enter these files into your system.
4. SASTM is a registered trademark of the SAS Institute, Inc., Cary, NC 27511-8000.
5. ARC/INFOTM is a registered trademark of the Environmental Systems Research Institute, Inc., Redlands, CA 92372.

15. Contents of the Descriptive File

The following is a listing of the first file provided on the magnetic tape distributed by CDIAC. This file provides variable descriptions, formats, units, and other pertinent information about each file associated with this coastal hazards data base.

Title of the Data Base

A Coastal Hazards Data Base for the U.S. Gulf Coast

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Scope of the Data

The 29 data variables within *A Coastal Hazards Data Base for the U.S. Gulf Coast*, and the corresponding coastal vulnerability indices that may be derived, may be used by coastal planning, research, and management agencies to identify shorelines at risk from coastal erosion and inundation. This data base should be used to identify areas where further study is necessary. In addition, these data may be used in combination with appropriate climatological data (e.g., Birdwell and Daniels, 1991) to identify coastal areas that are vulnerable to coastal erosion and inundation from sea level rise or storm surge.

This data base is comprised of the following data sets: elevation, bedrock geology, geomorphology, sea level trends, horizontal shoreline movements (erosion/accretion), tidal ranges, and wave heights. For several of these data sets minimum, mean, and maximum data values are available. These data variables may be divided into two basic classes, one that measures erosion potential and one that is related to inundation risk. The erosion risk of each coastal grid cell or line segment may be determined based on geology, geomorphology, shoreline displacement, tidal ranges and wave heights, while the inundation risk may be estimated based on sea level trends and elevations.

Seven of the 29 data variables in this data base are classified versions of other variables within this data base. The seven classified risk variables contain "risk values" of one to five for each coastal grid cell in the data base. These risk variables may be used to calculate a Coastal Vulnerability Index (CVI) that may be used to identify areas on the U.S. Gulf Coast that are vulnerable to sea level rise or coastal erosion.

Data Formats

For ease of use, this data base has been divided into five data groups or coverages. Each of these five data groups are provided in two different data formats. The first format is designed for use by the ARC/INFO™ Geographic Information System (GIS). This format stores the data as polygons (e.g., GCGRID and GCRISK), as arcs (e.g., GCLINE and GCOAST), or as points (e.g., GCPOINT). The second format contains comparable data that has been converted into flat ASCII data files for use by raster GISs or non-GIS data base systems.

The first two data groups are registered to a 0.25° latitude by 0.25° longitude grid. The first, GCGRID (Files 4 and 5) provides the 22 original data variables, while the second data group, GCRISK (Files 8 and 9) provides the seven relative risk variables.

The third data group is registered to a 1:2,000,000 digitized U.S. Gulf coastline, GCLINE (Files 12 and 13), and provides 29 data variables (i.e., the 22 original and the seven relative risk data variables).

The fourth data group, GCPOINT (Files 16 and 17), was originally obtained as point data. This data group provides the source information used in the development of the tidal range and sea-level-trends data sets. Data variables included in this data group are station names/numbers, record lengths, and longitude/latitude locations of the actual data point. These data represent the physical location of the occurring data point, and will allow the precise location of each station used in calculating the gridded tidal range and sea-level-rise data variables within the 0.25° grid cells of data groups GCGRID and GCRISK.

Finally, the last group contains an auxiliary file, a 1:2,000,000 digitized coastline of the U.S. Gulf Coast, GCOAST (files 20 and 21). These line segments are identical to those found in data group GCLINE, however no data values are provided.

A description of the contents of each of the data groups and files included with this data base follows:

- (1) **GCGRID:** Gridded polygon data for the 22 original data variables. Data sets contained in this group include elevation, geology, geomorphology, sea level trends shoreline displacement (erosion/accretion), tide ranges and wave heights.
- (2) **GCRISK:** Gridded polygon data for the seven classified risk variables. The risk variables are classified versions of the following original variables: mean coastal elevation, geology, geomorphology, local subsidence trend, mean shoreline displacement, mean tidal range, and maximum significant wave height.
- (3) **GCLINE:** 1:2,000,000 digitized line segment data for the U.S. Gulf Coast containing the 29 data variables (i.e., the 22 original data variables and the seven classified risk variables). Data contained within this group include elevation, geology, geomorphology, sea level trend, horizontal shoreline displacement, tide range and wave heights. The seven risk variables are classified versions of the following original data variables: mean coastal elevation, geology, geomorphology, local subsidence trend, mean shoreline displacement, mean tidal range, and the maximum significant wave height.

- (4) **GCPOINT:** Point data for the stations used in calculating the sea-level-trend and tide-range data sets. Data include station names/numbers, record length, latitude/longitude location, and mean and maximum data values (when available).
- (5) **GCOAST:** 1:2,000,000 digitized coastline of the U.S. Gulf Coast. The coastline was extracted from a digitized map of the United States compiled by the U.S. Geological Survey.

To improve the portability of the information in the data files, FORTRAN and SASTM input/output routines have been included with this data base for each of the flat ASCII data files. These input/output routines are intended to be used to read/write the data values contained in the flat ASCII data files [containing the gridded data base, the original point data (for the sea level trend and tide range variables), and the digitized U.S. Gulf coastline].

The data groups in this data base are available as exported ARC/INFOTM coverages (Version 6.0.1). The export files **must be read into an ARC/INFOTM GIS using the IMPORT command with the COVER option** after uploading the files onto a computer. These files are in a GEOGRAPHIC projection, which means the coverages are projected in a spherical reference grid using latitude and longitude coordinates that are stored in decimal degrees (DD). The flat ASCII files contain an identical version of this data base. The gridding method used in this data base consists of 0.25° latitude by 0.25° longitude grid cells. These cells cover the area defined by the following coordinates: 100°W, 24°N; 100°W, 32°N; 80°W, 32°N; and 80°W, 24°N. The origin of the grid is at 100°W, 24°N, and grid identifiers increase from left to right, bottom to top. The data contained within each grid cell is an average for the entire grid cell. The grid cell identification number is located in the center of each cell and although it is not the physical location of each data value, it represents averages for all data points located within the cell.

The flat ASCII versions of the files have been provided to allow use of these data by users who do not have access to ARC/INFOTM. The format and contents of each of the flat ASCII files are described in the following section (the ARC/INFOTM coverages have the same variables and general format as described herein for the ASCII files).

Data Group GCGRID:

This data group contains gridded data for the 22 original data variables. These data variables are from the seven data sets and are as follows: mean, maximum, and minimum elevation, and the number of 5' grid cells used in deriving the data values; geology; geomorphology; relative sea level trend, global-trend, corrected sea level trend, local subsidence trend, and the years of record of the gauge stations used in calculating these values; mean, maximum, and minimum shoreline displacement, and the number of 3', 7.5', or 15' grid cells used in deriving the data values; mean and maximum tidal range, mean tide level, and the number of tidal stations used in calculating these values; 20 year mean wave height, maximum significant wave height, and the 20 year mean wave height standard deviation.

The names of the ARC/INFO™ coverage and flat ASCII files providing these data are GCGRID.E00 (File 4) and GCGRID.ASC (File 5), respectively. File 5 is formatted as follows:

```
10 READ(5,100,END=999) ID,ELAVG,ELMAX,ELMIN,
1  ELNUM,GL,GM,SLR,SLG,SLC,SLYR
  READ(5,110) ERAVG,ERMAX,ERMIN,ERNUM,TRAVG,
1  TRMAX,TRLVL,TRNUM,WHAVG,WHMAX,WHSD
100 FORMAT(I5,4F8.2,2I4,3F8.2,I4)
110 FORMAT(3F8.2,I4,3F8.2,I4,3F8.2)
```

The variables in data group GCGRID (File 5) are shown in Table 8 and are listed as they appear in the file.

Table 8. Variable formats for GCGRID.ASC (File 5).

Variable name	Column		Variable type	Variable description
	Start	End		
ID	1	5	Integer	System variable - grid cell identifier.
ELAVG	6	13	Real	Data variable - mean elevation of all positive 5' by 5' grid cells within a given 0.25° grid cell; values in meters.
ELMAX	14	21	Real	Data variable - maximum elevation of all positive 5' by 5' grid cells within a given 0.25° grid cell; values in meters.
ELMIN	22	29	Real	Data variable - minimum elevation of all positive 5' by 5' grid cells within a given 0.25° grid cell; values in meters.
ELNUM	30	33	Integer	Data variable - number of 5' by 5' grid cells used in calculating ELAVG, ELMIN, and ELMAX for a given 0.25° grid cell.
GL	34	37	Integer	Data variable - ordinal value indicative of the type and resistance of the rocks within a given 0.25° grid cell to erosion.

Table 8. (continued)

Variable name	Column		Variable type	Variable description
	Start	End		
GM	38	41	Integer	Data variable - ordinal value indicative of the type and susceptibility of the landforms within a given 0.25° grid cell to inundation and erosion.
SLR	42	49	Real	Data variable - relative sea-level trend within a given 0.25° grid cell; values in mm/year.
SLG	50	57	Real	Data variable - long-term geologic trend derived from C ¹⁴ data for each 0.25° grid cell; values in mm/year.
SLC	58	65	Real	Data variable - corrected sea-level trend. Tide-gauge data (i.e., SLR) corrected for geologic trends (i.e., SLG) for each 0.25° grid cell.
SLS	66	73	Real	Data variable - the local subsidence trend. Tide-gauge data (i.e., SLR) corrected for the global eustatic rate of sea level rise (i.e., 1.5 mm/year).
SLYR	74	77	Integer	Data variable - years of record used in estimating the sea level trend for each 0.25° grid cell.

----- SECOND LINE READS AS FOLLOWS -----

ERAVG	1	8	Real	Data variable - mean long-term erosion trend for a given 0.25° grid cell; values in meters.
ERMAX	9	16	Real	Data variable - maximum long-term erosion trend for a given 0.25° grid cell; values in meters.

Table 8. (continued)

Variable name	Column		Variable type	Variable description
	Start	End		
ERMIN	17	24	Real	Data variable - minimum long-term erosion trend for a given 0.25° grid cell; values in meters.
ERNUM	25	28	Integer	Data variable - number of 3', 7.5', or 15' grid cells used in calculating ERAVG, ERMIN, and ERMAX for a given 0.25° grid cell.
TRAVG	29	36	Real	Data variable - average of the mean tide range for all the gauge stations that occur within a given 0.25° grid cell (mean tide range is the difference in height between mean high water and mean low water in 1992); values in meters.
TRMAX	37	44	Real	Data variable - maximum tide range measured for all gauge stations that occurred within a given 0.25° grid cell in 1992 (this value may be the "spring" or "diurnal" tide range, depending on geographic location); values in meters.
TRLVL	45	52	Real	Data variable - the average of the mean tide levels of all the gauge stations that occur within a given 0.25° grid cell (mean tide level is a plane midway between mean low water and mean high water in 1992). Values were reckoned from chart datums (i.e., the Gulf Coast Mean Low Water Datum).

Table 8. (concluded)

Variable name	Column		Variable type	Variable description
	Start	End		
TRNUM	53	56	Integer	Data variable - number of tide gauge stations used in calculating TRAVG, TRMAX, and TRLVL for a given 0.25° grid cell.
WHAvg	57	64	Real	Data variable - 20-year mean wave height experienced within each 0.25° grid cell; values in meters.
WHMAX	65	72	Real	Data variable - maximum significant wave height for each 0.25° grid cell; values in meters.
WHSD	73	80	Real	Data variable - standard deviation of the 20-year mean wave height experienced within each 0.25° grid cell; values in meters.

Within GCGRID missing data values are identified as follows:

9999.99 — A grid cell with real data values that is missing data for a given data variable.

9999 — A grid cell with integer data values that is missing data for a given data variable.

A value of 0.0 is a valid value for all variables. For the elevation variables 0.0 m indicates that land occurs within the given grid cell, but the mean elevation of this land is < 1.0 m. If the data variables in a given data set, such as elevation, contain data and the "number" variable is set to zero (i.e., ELNUM, ERNUM, TRNUM, or SLR), then the data variables for the given 0.25° grid cell have been estimated.

Data Group GCRISK:

This data group contains gridded data for the seven classified risk variables. These risk variables are classified versions of the following original variables: mean coastal elevation, geology, geomorphology, local subsidence trend, mean shoreline displacement, mean tidal range, and maximum significant wave height.

The names of the ARC/INFO™ coverage and flat ASCII files are GCRISK.E00 (File 8) and GCRISK.ASC (File 9), respectively. A summary of the format used in File 9 follows:

```
10 READ(5,100,END=999) ID,
  1 ELR,GLR,GMR,LSR,ERR,TRR,WHR
100 FORMAT(15,714)
```

The variables in data group GCRISK, listed in Table 9, are shown as they appear in File 9.

Table 9. Variable formats for GCRISK.ASC (File 9).

Variable name	Column		Variable type	Variable description
	Start	End		
ID	1	5	Integer	System variable - grid cell identifier.
ELR	6	9	Integer	Data variable - classified version of the mean elevation variable (i.e., ELAVG).
GLR	10	13	Integer	Data variable - classified version of the geology variable (i.e., GL).
GMR	14	17	Integer	Data variable - classified version of the geomorphology variable (i.e., GM).
LSR	18	21	Integer	Data variable - classified version of the local subsidence trend variable (i.e., SLS).
ERR	22	25	Integer	Data variable - classified version of the mean erosion/accretion variable (i.e., ERAVG).
TRR	26	29	Integer	Data variable - classified version of the mean tide range variable (i.e., TRAVG).
WHR	30	33	Integer	Data variable - classified version of the maximum significant wave- height variable (i.e., WHMAX).

A value of zero (0) is used to identify missing data values within the grid cell for the risk variables. If several "no data" values occur within the same grid cell, then any calculated coastal vulnerability index that uses these relative risk factors may not accurately represent the risk of the given coastal area to sea level rise or coastal erosion (unless some type of corrective action is taken). Grid cells that are not in the coastal zone, or are totally ocean bound, have values of zero for all seven derived risk variables.

Data Group GCLINE:

This data group contains 1:2,000,000 digitized line segment for the 29 data variables contained within this data base (i.e., the 22 original and the seven relative risk data variables). These data variables are from the seven data sets and are as follows: mean, maximum, and minimum elevation, the number of 5' grid cells used in deriving the data values, and the elevation risk (i.e., the classified version of the mean elevation variable); geology and the geology risk (i.e., the classified version of the geology variable); geomorphology and geomorphology risk (i.e., the classified version of the geomorphology variable); relative sea level trend, global-trend, corrected sea level trend, local subsidence trend, the years of record of the gauge stations used in calculating these values, and the local subsidence trend risk (i.e., the classified version of the local subsidence trend variable); mean, maximum, and minimum shoreline displacement, the number of 3', 7.5', or 15' grid cells used in deriving the data values, and erosion risk (i.e., the classified version of the mean erosion/accretion variable); mean and maximum tidal range, mean tide level, the number of tidal stations used in calculating these values, and the tidal-range risk (i.e., the classified version of the mean tidal range); 20 year mean wave height, maximum significant wave height, the 20 year mean wave height standard deviation, and the wave-height risk (i.e., classified version of the maximum significant wave-height variable).

The names of the ARC/INFOTM coverage and flat ASCII file that provide these data variables are GCLINE.E00 (File 12) and GCLINE.ASC (File 13), respectively. File 13 is formatted as follows:

```
10 read(5,100,end=999) id,elavg,elmax,elmin,elnum,
  1 elr,gl,glr,gm,gmr,slr,slg,slc,sls,
  1 slyr,lsr
  read(5,110) eravg,ermax,ermin,ernum,err,travg,
  1 trmax,trlvl,trnum,trr,whavg,whmax,
  1 whsd,whr
100 format(i5,3f8.2,6i4,4f8.2,2i4)
110 format(3f8.2,2i4,3f8.2,2i4,3f8.2,i4)
```

The variables in data group GCLINE (File 13) are shown in Table 10 and are listed as they appear in the file.

Table 10. Variable formats for GCLINE.ASC (File 13).

Variable name	Column		Variable type	Variable description
	Start	End		
ID	1	5	Integer	System variable - grid cell identifier.
ELAVG	6	13	Real	Data variable - mean elevation of all positive 5' by 5' grid cells within a given 0.25° grid cell; values in meters.
ELMAX	14	21	Real	Data variable - maximum elevation of all positive 5' by 5' grid cells within a given 0.25° grid cell; values in meters.
ELMIN	22	29	Real	Data variable - minimum elevation of all positive 5' by 5' grid cells within a given 0.25° grid cell; values in meters.
ELNUM	30	33	Integer	Data variable - number of 5' by 5' grid cells used in calculating ELAVG, ELMIN, and ELMAX for a given 0.25° grid cell.
ELR	34	37	Integer	Data variable - classified version of the mean elevation variable (i.e., ELAVG).
GL	38	41	Integer	Data variable - ordinal value indicative of the type and resistance of the rocks within a given 0.25° grid cell to erosion.
GLR	42	45	Integer	Data variable - classified version of the geology variable (i.e., GL).

Table 10. (continued)

Variable name	Column		Variable type	Variable description
	Start	End		
GM	46	49	Integer	Data variable - ordinal value indicative of the type and susceptibility of the landforms within a given 0.25° grid cell to inundation and erosion.
GMR	50	53	Integer	Data variable - classified version of the geomorphology variable (i.e., GM).
SLR	54	61	Real	Data variable - relative sea level trend within a given 0.25° grid cell; values in mm/year.
SLG	62	69	Real	Data variable - long-term geologic trend derived from C ¹⁴ data for each 0.25° grid cell; values in mm/year.
SLC	70	77	Real	Data variable - corrected sea level trend. Tide-gauge data (i.e., SLR) corrected for geologic trends (i.e., SLG) for each 0.25° grid cell.

----- SECOND LINE READS AS FOLLOWS -----

SLS	1	8	Real	Data variable - the local subsidence trend. Tide-gauge data (i.e., SLR) corrected for the global eustatic rate of sea level rise (i.e., 1.5 mm/year).
SLYR	9	12	Integer	Data variable - years of record used in estimating the sea level trend for each 0.25° grid cell.

Table 10. (continued)

Variable name	Column		Variable type	Variable description
	Start	End		
LSR	13	16	Integer	Data variable - classified version of the local subsidence trend variable (i.e., SLS).
ERAVG	17	24	Real	Data variable - mean long-term erosion trend for given 0.25° grid cell; values in meters.
ERMAX	25	32	Real	Data variable - maximum long-term erosion trend for a given 0.25° grid cell; values in meters.
ERMIN	33	40	Real	Data variable - minimum long-term erosion trend for a given 0.25° grid cell; values in meters.
ERNUM	41	44	Integer	Data variable - number of 3', 7.5', or 15' grid cells used in calculating ERAVG, ERMIN, and ERMAX for a given 0.25° grid cell.
ERR	45	48	Integer	Data variable - classified version of the mean erosion/accretion variable (i.e., ERAVG).
TRAVG	49	55	Real	Data variable - average of the mean tide range for all the gauge stations that occur within a given 0.25° grid cell (mean tide range is the difference in height between mean high water and mean low water in 1992); values in meters.

Table 10. (continued)

Variable name	Column		Variable type	Variable description
	Start	End		
TRMAX	56	64	Real	Data variable - maximum tide range measured for all gauge stations that occurred within a given 0.25° grid cell in 1992 (this value may be the "spring" or "diurnal" tide range, depending on geographic location); values in meters.
TRLVL	65	72	Real	Data variable - the average of the mean tide levels of all the gauge stations that occur within a given 0.25° grid cell (mean tide level is a plane midway between mean low water and mean high water in 1992). Values were reckoned from chart datums (i.e., the Gulf Coast Mean Low Water Datum).
TRNUM	73	76	Integer	Data variable - number of tide gauge stations used in calculating TRAVG, TRMAX, and TRLVL for a given 0.25° grid cell.
TRR	77	80	Integer	Data variable - classified version of the mean tide range variable (i.e., TRAVG).

----- **THIRD LINE READS AS FOLLOWS** -----

WHAVG	1	8	Real	Data variable - 20-year mean wave height experienced within each 0.25° grid cell; values in meters.
-------	---	---	------	---

Table 10. (concluded)

Variable name	Column		Variable type	Variable description
	Start	End		
WHMAX	9	16	Real	Data variable - maximum significant wave height for each 0.25° grid cell; values in meters.
WHSD	17	24	Real	Data variable - standard deviation of the 20-year mean wave height experienced within each 0.25° grid cell; values in meters.
WHR	25	28	Integer	Data variable - classified version of the maximum significant wave-height variable (i.e., WHMAX).

Within GCLINE missing data values are indicated as follows:

9999.99 — A line segment with real data values that is missing data for a given data variable.

9999 — A line segment with integer data values that is missing data for a given data variable.

0 — A line segment with missing data values for the risk variables.

A value of 0.0 is a valid value for all variables. For the elevation variables 0.0 m indicates that land occurs within the given grid cell, but the maximum elevation of this land is < 1.0 m. If the data variables in a given data set, such as elevation, contain data and the "number" variable is set to zero (i.e., ELNUM, ERNUM, TRNUM, or SLR), then the data variables for the given 0.25° grid cell have been estimated.

Data Group GCPOINT:

This data group contains the point data for the stations used in calculating the relative sea level trend, long-term geologic-trend, corrected sea level trend, local subsidence trend, mean tide range, maximum tide range, and mean tide level variables contained within data group GCGRID. Data include station names, station number, record length, latitude/longitude location, and data variable values.

The names of the ARC/INFO™ coverage and flat ASCII file are GCPOINT.E00 (File 16 and GCPOINT.ASC (File 17), respectively. A summary of the format used for File 17 follows:

```

10 READ(5,100,END=999) ID,SLLONG,SLLAT,SLR,SLG,
  1 SLC,SLS,SLYR,SLNAME
  READ(5,110) TRLONG,TRLAT,TRAVG,TRMAX,TRLVL,
  1 TRID,TRNAME
100 FORMAT(15,6F8.2,I4,A38)
110 FORMAT(5F8.2,15,A45)

```

The variables listed in Table 11 are listed as they appear in data group GCPOINT (File 17).

Table 11. Variable formats for GCPOINT.ASC (File 17).

Variable name	Column		Variable type	Variable description
	Start	End		
ID	1	5	Integer	System variable - Point identification number.
SLLONG	6	13	Real	Data variable - longitude of the tide- gauge station used in determining the sea level trends.
SLLAT	14	21	Real	Data variable - latitude of the tide- gauge station used in determining the sea level trends.
SLR	22	29	Real	Data variable - relative sea level trend measured for each tide-gauge station; values are expressed in mm/year.
SLG	30	37	Real	Data variable - long-term geologic trend derived from C ¹⁴ data; values are expressed in mm/year.

Table 11. (continued)

Variable name	Column		Variable type	Variable description
	Start	End		
SLC	38	45	Real	Data variable - corrected sea level trend. Tide-gauge data (i.e., SLR) corrected for long-term geologic-trends (i.e., SLG); values are expressed in mm/year.
SLS	46	53	Real	Data variable - local subsidence trend. Relative sea level trend corrected for the global eustatic rate of sea level rise (i.e., 1.5 mm/year).
SLYR	54	57	Integer	Data variable - years of record of the tide gauge station used in determining the sea level trends.
SLNAME	58	81	Char	Data variable - name of the tide gauge used for determining the sea level trends.

----- SECOND LINE READS AS FOLLOWS -----

TRLONG	1	8	Real	Data variable - longitude of a tide-gauge station used for determining the tide range ariables.
TRLAT	9	16	Real	Data variable - latitude of a tide-gauge station used for determining the tide range variables.
TRAVG	17	24	Real	Data variable - difference between mean high water and mean low water for 1992; values in meters.

Table 11. (concluded)

Variable name	Column		Variable type	Variable description
	Start	End		
TRMAX	25	32	Real	Data variable - maximum tide range, maximum measured range for the gauge station in 1992 (this value may be the "spring" or "diurnal" tide range, depending on geographic location); values in meters.
TRLVL	33	40	Real	Data variable - mean tide level, a plane midway between mean low water and mean high water in 1992. Values are reckoned from chart datums (i.e., the Gulf Coast Mean Low Water Datum).
TRID	41	44	Integer	Data variable - station number (used in the 1992 Tide Tables) of a tide-gauge station.
TRNAME	45	81	Char	Data variable - name of a tide-gauge station (from the 1992 Tide Tables).

Within this data file, GCPOINT, missing data values are indicated with one of the following values:

0.0 or 0 - A tide range or sea-level station that has not been assigned data for the variable in question.

In this data group the sea level variables and tide range variables are mutually exclusive (i.e., if tide-range data are present, then the sea-level data are missing or vice versa).

Data Group GCOAST:

Auxiliary data group GCOAST (Files 20 and 21) contains a 1:2,000,000 digitized coastline of the U.S. Gulf Coast. Data in this coverage were extracted from a digitized map of the United States (originally compiled by the U.S. Geological Survey). This coastline may be overlaid onto any of the four data groups previously discussed to provide locational information when plotting any or all of the data variables.

This coverage contains line segments (or arcs) that describe the Gulf Coast. The coastline provided has no attribute values associated with the line segments. However, an overlay command such as IDENTITY in ARC/INFO™ may be used to transfer the gridded data values to the coastal segments, thus simplifying the interpretation of any derived indices.

The name of the ARC/INFO™ coverage where the coastline resides is GCOAST.E00 (File 20), and the flat ASCII data file with this same information is in GCOAST.ASC (File 21). Since this file is line based, the data values in GCOAST.ASC contain the line segment name, and a listing of the points that describe each line, for each of the 2017 line segments that define the Gulf Coast.

The flat ASCII version of this file (file 21) contains a listing of the line segments (or arcs) that describe the coast. An example of the format for this file is shown in Table 12.

Table 12. Sample of the vector format used for GCOAST.ASC (File 21).

Name, Number of points - Data points	Data interpretation
" 1", -14	-Vector 1 uses 14 points to describe the line
-88.0000,30.7848	-Start at -88.00 W. Longitude, 30.78 N. Latitude
-87.9967,30.7839	
-87.9915,30.7806	
-87.9883,30.7806	
-87.9856,30.7806	
-87.9825,30.7755	
-87.9821,30.7705	
-87.9821,30.7677	
-87.9827,30.7645	
-87.9843,30.7627	
-87.9876,30.7605	
-87.9898,30.7573	
-87.9946,30.7551	
-88.0000,30.7529	
" 2", -35	-Vector 2 uses 35 points to describe the line
-87.9361,30.7515	-Start at 87.94 W Longitude, 30.75 N Latitude
-87.9355,30.7556	
...	-Continued

16. Listing of the FORTRAN Data Retrieval Programs

This section lists the five FORTRAN data retrieval programs provided by CDIAC on 9-track magnetic tapes, 8mm tapes, quarter inch tape cartridges, floppy diskette, or through CDIAC's anonymous FTP service with this data base. Each program is designed to read and write the contents of one of the five flat ASCII data files.

The first program (GCGRID.FOR, File 2) is designed to read and print the file GCGRID.ASC (File 5).

```
c*****
c* fortran program to read and write gcgrid.asc (file 5)      *
c*****
  integer nlin
  integer id, elnum, gl, gm, slr, ernum, trnum
  real   elavg, elmax, elmin, slr, slg, slc, sls
  real   eravg, ermax, ermin, travg, trmax, trlvl
  real   whavg, whmax, whsd
c*****
c* initialize a counter and open files for input/output      *
c*****
  nlin=0
  open(unit=5,file='gcgrid.asc',readonly,status='old')
  open(unit=6,file='gcgrid.out',status='new')

c*****
c* read/write the grid cell id and the 22 data variables      *
c*****
10 read(5,100,end=999) id, elavg, elmax, elmin, elnum,
   1  gl, gm, slr, slg, slc, sls, slr
   read(5,110) eravg, ermax, ermin, ernum, travg,
   1  trmax, trlvl, trnum, whavg, whmax, whsd

  if (nlin.gt.32) nlin=0
  if (nlin.eq.0) write (6,120)
  if (nlin.eq.0) write (6,130)
  nlin=nlin+1

  write(6,105) id, elavg, elmax, elmin, elnum,
   1  gl, gm, slr, slg, slc, sls, slr
  write(6,115) eravg, ermax, ermin, ernum, travg,
   1  trmax, trlvl, trnum, whavg, whmax, whsd
20 continue
  go to 10
100 format (i5,3f8.2,3i4,4f8.2,i4)
105 format (1x,i5,3f8.2,3i4,4f8.2,i4)
110 format (3f8.2,i4,3f8.2,i4,3f8.2)
115 format (1x,3f8.2,i4,3f8.2,i4,3f8.2)
```

```

120 format (4x,'id',1x,'elavg',3x,'elmax',3x,'elmin',1x,
1   'elnum',2x,'gl',2x,'gm',1x,'slr',5x,'slg',5x,'slc',
1   5x,'sls',4x,'slyr')
130 format (2x,'eravg',3x,'ermax',3x,'ermin',1x,'ernum',
1   1x,'travg',3x,'trmax',3x,'trlvl',1x,'trnum',1x,
1   'whavg',3x,'whmax',3x,'whsd')
c*****
c*****      close files and exit      *****
c*****
999 close(unit=5)
   close(unit=6)
   stop
   end

```

The second FORTRAN program (GCRISK.FOR, File 6) is designed to read and print the file GCRISK.ASC (File 9).

```

c*****
c* fortran program to read and write gcrisk.asc (file 9)      *
c*****
   integer nlin
   integer id, elr, glr, gmr, lsr, err, trr, whr
c*****

c* initialize a counter and open files for input/output      *
c*****
   nlin=0
   open(unit=5,file='gcrisk.asc',readonly,status='old')
   open(unit=6,file='gcrisk.out',status='new')
c*****
c* read/write the grid cell id and the 7 risk variables      *
c*****
10 read(5,100,end=999) id, elr, glr, gmr, lsr,
1   err, trr, whr

   if (nlin.gt.63) nlin=0
   if (nlin.eq.0) write (6,110)
   nlin=nlin+1

   write(6,105) id, elr, glr, gmr, lsr,
1   err, trr, whr
20 continue
   go to 10
100 format (i5,7i4)
105 format (1x,i5,7i4)
110 format (4x,'id',1x,'elr',1x,'glr',1x,'gmr',1x,
1   'lsr',1x,'err',1x,'trr',1x,'whr')

```



```

c*****
c*****      close files and exit      *****
c*****
999 close(unit=5)
   close(unit=6)
   stop
   end

```

The third FORTRAN program (GCLINE.FOR, File 10) is designed to read and print the file GCLINE.ASC (File 13).

```

c*****
c* fortran program to read and write gcline.asc (file 13)      *
c*****
   integer nlin
   integer id, elnum, gl, gm, slyr, ernum, trnum
   integer elr, glr, gmr, slr, err, trr, whr
   real   elavg, elmax, elmin, slr, slg, slc, sls
   real   eravg, ermax, ermin, travg, trmax, trlvl
   real   whavg, whmax, whsd
c*****
c* initialize a counter and open files for input/output      *
c*****
   nlin=0
   open(unit=5,file='gcline.asc',readonly,status='old')
   open(unit=6,file='gcline.out',status='new')
c*****
c* read/write the line segment id and the 29 data variables      *
c*   including the 22 original and 7 risk data variables      *
c*****
10 read(5,100,end=999) id, elavg, elmax, elmin, elnum,
   1   elr, gl, glr, gm, gmr, slr, slg, slc, sls,
   1   slyr, lsr
   read(5,110) eravg, ermax, ermin, ernum, err, travg,
   1   trmax, trlvl, trnum, trr, whavg, whmax,
   1   whsd, whr

   if (nlin.gt.32) nlin=0
   if (nlin.eq.0) write (6,120)
   if (nlin.eq.0) write (6,130)

   nlin=nlin+1
   write(6,105) id, elavg, elmax, elmin, elnum, elr,
   1   gl, glr, gm, gmr, slr, slg, slc, sls, slyr, lsr
   write(6,115) eravg, ermax, ermin, ernum, err, travg,
   1   trmax, trlvl, trnum, trr, whavg, whmax, whsd, whr
20 continue
   go to 10

```

```

100 format (i5,3f8.2,6i4,4f8.2,2i4)
105 format (1x,i5,3f8.2,6i4,4f8.2,2i4)
110 format (3f8.2,2i4,3f8.2,2i4,3f8.2,i4)
115 format (1x,3f8.2,2i4,3f8.2,2i4,3f8.2,i4)

120 format (4x,'id',3x,'elavg',3x,'elmax',1x,'elmin',
1 1x,'elnum',1x,'elr',2x,'gl',1x,'glr',2x,'gm',
1 1x,'gmr',4x,'slr',5x,'slg',5x,'slc',5x,'sls',
1 1x,'slyr',1x,'lsr')

130 format (4x,'eravg',3x,'ermax',1x,'ermin',1x,'ernum',
1 1x,'err',3x,'travg',3x,'trmax',1x,'trlvl',
1 1x,'trnum',1x,'trr',3x,'whavg',3x,'whmax',
1 4x,'whsd',1x,'whr')

```

```

c*****
c*****      close files and exit      *****
c*****
999 close(unit=5)
    close(unit=6)
    stop
    end

```

The fourth FORTRAN program (GCPOINT.FOR, file 14) is designed to read and print the file GCPOINT.ASC (File 17).

```

c*****
c* fortran program to read and write gcpoint.asc (file 17)      *
c*****
    integer nlin
    integer id, slyr, trid
    real    sllong, sllat, slr, slg, slc, sls
    real    trlong, trlat, travg, trmax, trlvl
    character sname*40, trname*40
c*****
c* initialize a counter and open files for input/output      *
c*****
    nlin=0
    open(unit=5,file='gcpoint.asc',readonly,status='old')
    open(unit=6,file='gcpoint.out',status='new')
c*****
c* read/write the point id and the 15 station variables      *
c*****
10 read (5,100,end=999) id, sllong, sllat, slr, slg,
1  slc, sls, slyr, sname
   read(5,110) trlong, trlat, travg, trmax, trlvl,
1  trid, trname

```

```

      if (nlin.gt.32) nlin=0
      if (nlin.eq.0) write (6,120)
      if (nlin.eq.0) write (6,130)
      nlin=nlin+1
      write(6,105) id, sllong, sllat, slr, slg,
1      slc, sls, slyr, slname
      write(6,115) trlong, trlat, travg, trmax, trlvl,
1      trid, trname
20 continue
      go to 10

100 format (i5,6f8.2,i4,a40)
105 format (1x,i5,6f8.2,i4,a40)
110 format (5f8.2,i5,a40)
115 format (1x,5f8.2,i5,a40)
120 format (4x,'id',2x,'sllong',3x,'sllat',5x,'slr',
1      5x,'slg',5x,'slc',5x,'sls',1x,'slyr',1x,'slname')
130 format (3x,'trlong',3x,'trlat',3x,'travg',3x,'trmax',
1      3x,'trlvl',1x,'trid',1x,'trname')
c*****
c*****      close files and exit      *****
c*****
999 close(unit=5)
      close(unit=6)
      stop
      end

```

The last FORTRAN program (GCOAST.FOR, File 18) is designed to read and print the file GCOAST.ASC (File 21).

```

c*****
c* fortran program to read and write gcoast.asc (file 21)      *
c*****
      character name*6, allname*7
      character comma
      integer i, num, nlin
      real x, y
c*****
c*      open files for input/output      *
c*****
      open(unit=5,file='gcoast.asc',readonly,status='old')
      open(unit=6,file='gcoast.out',status='new')
c*****
c* read/write the line segment id and x,y coordinates      *

```

```

c*****
10 nlin=0
   read(5,100,end=999) name,comma,num
   if (comma.eq.'-') num=num*-1
   if (comma.eq.',') then
      allname=name//','
   else
      allname=name//' '
   end if

   write(6,130)
   write(6,110) allname, num

c*****
c*  read and print x,ycoordinates for the line
c*****
   do 20 i = 1, num*-1
      if (nlin.gt.77) nlin=0
      if (nlin.eq.0) write (6,140)
      nlin=nlin+1
      read (5,120) x,comma,y
      write (6,120) x,comma,y
20 continue
   go to 10

100 format (a6,a1,i6)
110 format (a7,i6)
120 format (f8.4,a1,f7.4)
130 format (1x,'name,number')
140 format (1x,'x      ,y ')

c*****
c*****      close files and exit      *****
c*****
999 close(unit=5)
   close(unit=6)
   stop
   end

```

17. Listing of the SAS™ Data Retrieval Programs

This section lists the five SAS™ data retrieval programs provided by CDIAC with this data base. Each program is designed to read and write the contents of one of the five flat ASCII data files.

The first program (GCGRID.SAS, File 3) is designed to read and print the file GCGRID.ASC (File 5).

```
data gcgrid;
infile 'gcgrid.asc';
input id 1-5 elavg 6-13 elmax 14-21 elmin 22-29
      elnum 30-33 gl 34-37 gm 38-41 slr 42-49
      slg 50-57 slc 58-65 sls 66-73 slr 74-77;
input eravg 1-8 ermax 9-16 ermin 17-24 ernum 25-28
      travg 29-36 trmax 37-44 trlvl 45-52 trnum 53-56
      whavg 57-64 whmax 65-72 whsd 73-80;
proc print;
run;
```

The second SAS™ program (GCRISK.SAS, File 7) is designed to read and print the file GCRISK.ASC (File 9).

```
data gcrisk;
infile 'gcrisk.asc';
input id 1-5 elr 6-9 glr 10-13 gmr 14-17 lsr 18-21
      err 22-25 trr 26-29 whr 30-33;
proc print;
run;
```

The third SAS™ program (GCLINE.SAS, File 11) is designed to read and print the file GCLINE.ASC (File 13).

```
data gcline;
infile 'gcline.asc';
input id 1-5 elavg 6-13 elmax 14-21 elmin 22-29
      elnum 30-33 elr 34-37 gl 38-41 glr 42-45
      gm 46-49 gmr 50-53 slr 54-61 slg 62-69
      slc 70-77 sls 78-85 slr 86-89 lsr 90-93;
input eravg 1-8 ermax 9-16 ermin 17-24 ernum 25-28
      err 29-32 travg 33-40 trmax 41-48 trlvl 49-56
      trnum 57-60 trr 61-64 whavg 65-72 whmax 73-80
      whsd 81-88 whr 89-92;
proc print;
run;
```

The fourth SASTM program (GCPOINT.SAS, File 15) is designed to read and print the file GCPOINT.ASC (File 17).

```
data gcpoint;
infile 'gcpoint.asc';
input id 1-5 sllong 6-13 sllat 14-21 slr 22-29
      slg 30-37 slc 38-45 sls 46-53 slyr 54-57
      slname $ 58-97;
input trlong 1-8 trlat 9-16 travg 17-24 trmax 25-32
      trlvl 33-40 trid 41-44 trname $ 45-84;
proc print;
run;
```

The fifth SASTM program (File 19) is designed to read and print the file GCOAST.ASC (File 21).

```
data gcoast;
file 'gcoast.sout';
infile 'gcoast.asc' dlm=',';
input name $ num;
put @1 'name' @9 'number of points' @33 'x' @45 'y';
put @1 name @15 num @;
length default = 4;
num2 = num * -1;
array x{189};
array y{189};
do i = 1 to num2;
input x{i} y{i};
put @30 x{i} 8.4 @42 y{i} 8.4;
end;
run;
```

18. Partial Listings of the Flat ASCII Data Files

This section lists the first 15 data lines of each of the of the five flat ASCII data files provided with this data base.

Sample listing of GCGRID.ASC (file 5).

```
1 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
2 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
3 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
4 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
5 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
6 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
7 999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
8 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99 0 9999.99 9999.99 9999.99
9 9999.99 9999.99 9999.99 099999999 9999.99 9999.99 9999.99 9999.99 0
.....
```

Sample listing of GCRISK.ASC (file 9).

```
1 0 0 0 0 0 0 0 0
2 0 0 0 0 0 0 0 0
3 0 0 0 0 0 0 0 0
4 0 0 0 0 0 0 0 0
5 0 0 0 0 0 0 0 0
6 0 0 0 0 0 0 0 0
7 0 0 0 0 0 0 0 0
8 0 0 0 0 0 0 0 0
9 0 0 0 0 0 0 0 0
10 0 0 0 0 0 0 0 0
11 0 0 0 0 0 0 0 0
12 0 0 0 0 0 0 0 0
13 0 0 0 0 0 0 0 0
14 0 0 0 0 0 0 0 0
15 0 0 0 0 0 0 0 0
.....
```

Sample listing of GCLINE.ASC (file 13).

```

1 28.00 66.00 0.00 9 2 370 42224 5 2.60 0.00 2.60
1.10 0 3 0.00 0.00 0.00 0 0 1.30 1.30 0.60 1 2
0.00 0.00 0.00 0
2 28.00 66.00 0.00 9 2 370 42224 5 2.60 0.00 2.60
1.10 0 3 0.00 0.00 0.00 0 0 1.30 1.30 0.60 1 2
0.00 0.00 0.00 0
3 28.00 53.00 2.00 9 2 370 42224 5 2.60 0.00 2.60
1.10 0 3 0.00 0.00 0.00 0 0 0.00 0.00 0.00 0 0
0.00 0.00 0.00 0
4 28.00 53.00 2.00 9 2 370 41339 4 2.60 0.00 2.60
1.10 0 3 0.00 0.00 0.00 0 0 0.00 0.00 0.00 0 0
0.00 0.00 0.00 0
5 13.00 36.00 0.00 8 3 370 42224 5 2.50 0.00 2.50
1.00 0 2 0.00 0.00 0.00 0 0 1.50 1.50 0.80 1 2
0.00 0.00 0.00 0
6 13.00 36.00 0.00 8 3 370 42224 5 2.50 0.00 2.50
1.00 0 2 0.00 0.00 0.00 0 0 1.50 1.50 0.80 1 2
0.00 0.00 0.00 0
7 13.00 36.00 0.00 8 3 370 41339 4 2.50 0.00 2.50
1.00 0 2 0.00 0.00 0.00 0 0 1.50 1.50 0.80 1 2
0.00 0.00 0.00 0
8 13.00 36.00 0.00 8 3 370 42224 5 2.50 0.00 2.50
1.00 0 2 0.00 0.00 0.00 0 0 1.50 1.50 0.80 1 2
0.00 0.00 0.00 0
9 13.00 36.00 0.00 8 3 370 41339 4 2.50 0.00 2.50
1.00 0 2 .....

```

Sample 80-character partial listing of GCPOINT.ASC (file 17).

```

1 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.08 25.12 2.90 3.80 2.003451CAPE SABLE EAST CAPE
2 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.13 25.35 3.60 4.50 2.403453SHARK RIVER ENTRANCE
3 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.03 25.32 0.50 0.80 0.403455WHITEWATER BAY
4 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.22 25.55 3.00 3.90 2.103457LOSTMANS RIVER ENTRANCE
5 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.13 25.62 0.60 0.90 0.403459ONION KEY LOSTMANS RIVER
6 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.28 25.68 3.30 4.20 2.003461CHATHAM RIVER ENTRANCE
7 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.35 25.70 3.90 4.40 2.203463 PAVILION KEY
8 0.00 0.00 0.00 0.00 0.00 0.00 0
-81.38 25.85 2.00 2.60 1.303465EVERGLADES CITY BARRON RIVER
9 0.00 0.00 0.00 0.00 0.00 0.00 0
.....

```


Sample listing of GCOAST.ASC (file 21).

NAME	NUMBER
Wlong	Nlat
" 1",	-14
-88.0000,	30.7848
-87.9967,	30.7839
-87.9915,	30.7806
-87.9883,	30.7806
-87.9856,	30.7806
-87.9825,	30.7755
-87.9821,	30.7705
-87.9821,	30.7677
-87.9827,	30.7645
-87.9843,	30.7627
-87.9876,	30.7605
-87.9898,	30.7573
-87.9946,	30.7551
-88.0000,	30.7529
" 2",	-35
.....	

19. Verification of Data Transport: Flat ASCII Data Files

The gridded coastal hazards data base and the original point data may be read using the FORTRAN or SASTM input/output routines provided. After these files are loaded onto the system it should be verified that the files have not been corrupted during transport. To do this, some or all of the statistics or characteristics presented in the following tables should be generated. These statistics were obtained for GCGRID, GCRISK, GCLINE, GCPOINT, and GCOAST using the SASTM statistical package (i.e., with PROC MEANS); however, these statistics may be duplicated using other statistical packages or computer languages.

These statistics are presented only as a tool to ensure proper reading of the four flat ASCII data files and should not be construed as either a summary of the data or as an indicator of trends in the data.

Table 13. Statistical characteristics of the numeric variables in GCGRID.ASC (File 5).

Variable	N	Mean	Std. dev.	Minimum	Maximum
ID	2560	128.50	739.15	1.00	2560.00
ELAVG	2560	8969.11	3040.73	0.00	9999.99
ELMAX	2560	8969.34	3040.03	0.00	9999.99
ELMIN	2560	8968.88	3041.39	0.00	9999.99
ELNUM	2560	0.41	1.61	0.00	9.00
GL	2560	9021.36	2914.60	250.00	9999.00
GM	2560	9195.19	2399.15	1330.00	9999.00
SLR	2560	8867.77	3168.34	1.90	9999.99
SLG	2560	8867.20	3169.91	0.00	9999.99
SLC	2560	8867.74	3168.40	0.04	9999.99
SLS	2560	8867.58	3168.87	-1.21	9999.99
SLYR	2560	0.19	3.07	0.00	9999.99
ERAVG	2560	9437.42	2304.76	-9.24	9999.99
ERMAX	2560	9437.57	2304.17	-8.10	9999.99
ERMIN	2560	9437.30	2305.25	-36.00	9999.99
ERNUM	2560	0.92	6.61	0.00	124.00
TRAVG	2560	9402.43	2370.60	0.03	9999.99
TRMAX	2560	9402.44	2370.56	0.06	9999.99
TRLVL	2560	9402.39	2370.77	1.02	9999.99
TRNUM	2560	0.15	0.77	0.00	12.00
WHAVG	2560	9054.77	2925.94	0.47	9999.99
WHMAX	2560	9055.03	2925.14	2.30	9999.99
WHSD	2560	9054.72	2926.12	0.20	9999.99

Table 14. Statistical characteristics of the numeric variables in GCRISK.ASC (File 9).

Variable	N	Mean	Std. dev.	Minimum	Maximum
ID	2560	1280.50	739.15	1.00	2560.00
ELR	2560	0.48	1.43	0.00	5.00
GLR	2560	0.41	1.25	0.00	5.00
GMR	2560	0.38	1.17	0.00	5.00
LSR	2560	0.36	1.11	0.00	5.00
ERR	2560	0.20	0.85	0.00	5.00
TRR	2560	0.11	0.49	0.00	4.00
WHR	2560	0.18	0.58	0.00	3.00

Table 15. Statistical characteristics of the numeric variables in GCLINE.ASC (File 13).

Variable	N	Mean	Std. dev.	Minimum	Maximum
ID	2017	1009.00	582.40	1.00	2017.00
ELAVG	2017	1.95	4.05	0.00	29.00
ELMAX	2017	3.40	7.45	0.00	66.00
ELMIN	2017	0.64	1.67	0.00	16.00
ELNUM	2017	2.77	2.31	0.00	9.00
ELR	2017	4.82	0.67	0.00	6.00
GL	2017	346.12	36.80	250.00	370.00
GLR	2017	4.19	0.59	3.00	5.00
GM	2017	2084.43	566.53	0.00	9999.00
GMR	2017	3.78	0.95	0.00	5.00
SLR	2017	5.54	3.74	0.00	16.33
SLG	2017	0.00	0.00	0.00	0.00
SLC	2017	5.54	3.74	0.00	16.33
SLS	2017	4.04	3.73	-1.21	14.83
SLYR	2017	1.54	8.30	0.00	77.00
LSR	2017	3.57	1.36	0.00	5.00
ERAVG	2017	-1.00	2.25	-9.24	2.12
ERMAX	2017	0.92	6.86	-8.10	51.10
ERMIN	2017	-2.63	4.89	-36.00	1.60
ERNUM	2017	12.91	21.79	0.00	124.00
ERR	2017	2.28	1.88	0.00	5.00
TRAVG	2017	20.92	444.95	0.00	9999.99
TRMAX	2017	20.01	444.94	0.00	9999.99
TRLVL	2017	20.39	444.96	0.00	9999.99
TRNUM	2017	1.38	1.71	0.00	8.00
TRR	2017	1.39	1.21	0.00	4.00
WHAvg	2017	0.55	0.56	0.00	1.50
WHMAX	2017	1.82	1.85	0.00	4.70
WHSD	2017	0.18	0.19	0.00	0.50
WHR	2017	0.94	0.95	0.00	2.00

Table 16. Statistical characteristics of the numeric variables in GCPOINT.ASC (File 17).

Variable	N	Mean	Std. dev.	Minimum	Maximum
ID	199	100.00	57.59	1.00	199.00
SLLONG	199	-5.56	22.02	-97.92	0.00
SLLAT	199	1.73	6.83	0.00	30.40
SLR	199	0.40	1.88	0.00	0.00
SLG	199	0.00	0.00	0.00	0.00
SLC	199	0.40	1.88	0.00	14.00
SLS	199	0.31	1.59	0.00	12.50
SLYR	199	2.50	10.78	0.00	77.00
TRLONG	199	-81.75	21.26	-97.67	0.00
TRLAT	199	26.95	7.00	0.00	30.82
TRAVG	199	76.79	41.83	0.00	99.99
TRMAX	199	1.81	0.94	0.00	4.50
TRLVL	199	1.01	1.44	0.00	20.00
TRID	199	3419.05	874.80	0.00	3827.00

Table 17. Characteristics and size, in bytes and 512-byte blocks, of GCOAST.ASC (File 21).

Number of lines/arcs	Size in bytes	Size in blocks
2017	614020	1199

20. Verification of Data Transport: ARC/INFO™ Export Files

The five ARC/INFO™ export files were created in ARC/INFO™, Version 6.0.1, using the EXPORT command with the COVER and NONE options. Each export file contains an entire coverage and its associated INFO data files in a fixed-length, uncompressed format.

The exported coverages are in a GEOGRAPHIC projection, which is a spherical reference system that locates positions using latitude and longitude coordinates that are stored in decimal degrees. As a result of this, the reference grids in which the data are stored are *not* uniform in size or area.

After loading the ARC/INFO™ export files onto a system, the user should verify that the files have been correctly transported. To verify the integrity of the files, the size of the export files and (after importing the data into ARC/INFO™) the total number of INFO data records in each coverage should be compared with those presented in Table 18. If the file sizes differ from those presented by > 1 byte or the number of INFO data records do not match those shown in Table 18, then the coverage may have been corrupted in transport. Importation of the ARC/INFO™ .E00 files into the user's ARC/INFO™ system may be accomplished using the IMPORT command with the COVER option. The IMPORT command will automatically recognize that the export file is in an uncompressed format (files should be EXTERNALIZED after being imported [e.g., ARC> external GCGRID]).

Table 18. File size and number of INFO data records in each ARC/INFO™ export file.

Export file name	Tape file number	File size (bytes)	ARC/INFO™ data type	Number of ARC/INFO™ records
GCGRID.E00	4	2,041,835	.PAT	2561
GCRISK.E00	8	1,164,707	.PAT	2561
GCLINE.E00	12	1,335,350	.AAT	2017
GCPOINT.E00	16	64,537	.PAT	199
GCOAST.E00	20	683,451	.AAT	2017

APPENDICES

APPENDIX A

THE DATA GROUPS: A QUICK REFERENCE

THE DATA GROUPS: A QUICK REFERENCE

The following provides a listing and description of the data variables and other pertinent information for each of the five data groups. The ARC/INFOTM version of these files, contain several additional variables. These additional variables are system variables. For data groups GCGRID, GCRISK, and GCPOINT the system variables AREA, PERIMETER, COVERNAME# (i.e., cover name pound sign, an internal polygon, or point, identification number, and COVERNAME-ID (i.e., cover name dash identification number, an external polygon, or point identification number. The external identification number is present in both the export (.E00) and ASCII (.ASC) files and is used to identify the 0.25° by 0.25° grid cell to which the data record belongs. Groups GCLINE and GGCOAST contain the system variables: FNODE#, TNODE#, LPOLY#, RPOLY#, COVERNAME#, COVERNAME-ID and length. Since the ARC/INFOTM coverages are unprojected, the length is given in digitizing inches.

- (1) **Data Group GCGRID:** Gridded polygon data for 22 data variables from the following data sets: elevation, geology, geomorphology, sea level trend, shoreline displacement(erosion/accretion), tidal range, and wave heights. (A value of 9999.99 or 9999 indicates no data are available for the given data cell for a given data variable.)

Data Format - ARC/INFOTM coverage and flat ASCII file with data values for each 0.25° latitude by 0.25° longitude grid cell on the U.S. Gulf Coast.

File Storage - ARC/INFOTM coverage name is GCGRID.E00 (File 4) ASCII file name is GCGRID.ASC (File 5).

Data Variables

ELAVG - Average elevation calculated from all positive 5' by 5' grid cells within a given 0.25° grid cell; values expressed in meters.

ELMAX - Maximum elevation of all the positive 5' by 5' grid cells for a given 0.25° grid cell; values expressed in meters.

ELMIN - Minimum elevation of all the positive 5' by 5' grid cells for a given 0.25° grid cell; values expressed in meters.

ELNUM - Number of 5' by 5' grid cells used in calculating ELAVG, ELMIN, and ELMAX for a given 0.25° grid cell.

GL - Ordinal value indicating the type and resistance of the rocks within a given 0.25° grid cell to erosion through physical and chemical weathering.

GM - Ordinal value indicating the type and susceptibility of the landforms within a given 0.25° grid cell to inundation and erosion.

SLR - Relative sea level trend within a given 0.25° grid cell; values are expressed in mm/year. Data values are based on the point data in data group GCPOINT.

SLG - Geologic trend variable. In this data base this variable is 0.0. This data variable has been included to ensure compatibility between the data bases in this series of NDPs (i.e., NDP-043A, NDP-043B, and NDP-043C).

SLC - Corrected sea level trend derived from tide-gauge data (i.e., SLR) and corrected for geologic trends (i.e., SLG) for each 0.25° grid cell; values are expressed in mm/year. Data values are based on the point data in data group GCPOINT.

SLS - Local subsidence trend derived from tide-gauge data (i.e., SLR) and corrected for the global eustatic sea level trend (i.e., 1.5); values are expressed in mm/year. Data values are based on the point data in data group GCPOINT.

SLYR - Number of years of record used in estimating the sea level trend for each 0.25° grid cell (grid cells in which tide-gauge stations do not occur have been assigned a zero value.) Data values are based on the point data in data group GCPOINT.

ERAVG - Average of the mean long-term erosion trend values for a given 0.25° grid cell; values expressed in meters.

ERMAX - Maximum of the mean long-term erosion trends for a given 0.25° grid cell; values expressed in meters.

ERMIN - Minimum of the mean long-term erosion trends for a given 0.25° grid cell; values expressed in meters.

ERNUM - Number of 3', 7.5', or 15' grid cells (i.e., format of original data source) used in calculating ERAVG, ERMIN, or ERMAX for a given 0.25° grid cell.

TRAVG - Average of the mean-tide-range values for all tide stations occurring within a given 0.25° grid cell in 1992 (the mean tide range is the difference in height between mean high water and mean low water for 1992). Data values are expressed in meters and are based on the point data in data group GCPOINT.

TRMAX - Maximum tide range measured for all gauge stations that occurred within a given 0.25° grid cell in 1992 (this value may be the "spring" or "diurnal" tide range, depending on geographic location). Data values are expressed in meters and are based on the point data in data group GCPOINT.

TRLVL - Average of the mean-tide-level values for all tide stations occurring within a given 0.25° grid cell in 1992 (the mean tide level is a plane midway between mean low water and mean high water in 1992). Values are reckoned from chart datum, are expressed in meters, and are based on the point data in data group GCPOINT.

TRNUM - Number of tide-gauge stations used in calculating TRAVG, TRMAX, and TRLVL for a given 0.25° grid cell. Data values are based on the point data in data group GCPOINT.

WHA VG - 20-year mean wave height calculated for each 0.25° grid cell; values expressed in meters.

WHMAX - Maximum significant wave height for each 0.25° grid cell; values expressed in meters.

WHSD - Standard deviation of the mean wave heights experienced within each 0.25° grid cell; values expressed in meters.

- (2) **Data Group GCRISK:** Gridded polygon data for the seven classified risk variables. The risk variables contain values ranging from 0 to 5. A value of zero indicates no data are available for a given data variable, for a given grid cell. When the value for a given variable is greater than zero, the value indicates the relative risk of each 0.25° grid cell to inundation or erosion, with 5 indicating the greatest risk.

Data Format - ARC/INFO™ coverage and flat ASCII file with data values for each 0.25° latitude by 0.25° longitude grid cell on the U.S. Gulf Coast.

File Storage - ARC/INFO™ coverage name is GCRISK.E00 (File 8) ASCII file name is GCRISK.ASC (File 9).

Data Variables

ELR - Classified version of the mean elevation data variable (i.e., ELAVG).

GLR - Classified version of the geology data variable (i.e., GL).

GMR - Classified version of the geomorphology data variable (i.e., GM).

LSR - Classified version of the local subsidence trend data variable (i.e., SLS).

ERR - Classified version of the mean erosion/accretion data variable (i.e., ERAVG).

TRR - Classified version of the mean-tide-range data variable (i.e., TRAVG).

WHR - Classified version of the maximum significant wave-height variable (i.e., WHMAX).

- (3) **Data Group GCLINE:** 1: 2,000,000 digitized line segment data for the 22 original and 7 relative risk data variables from each of the seven data sets (i.e., elevation, geology, geomorphology, sea level trend, shoreline displacement, tidal range, and wave heights). A value of 9999.99 or 9999 indicates no data are available for the given data cell for a given data variable.)

Data Format - ARC/INFO™ coverage and flat ASCII file with data values for each 1:2,000,000 digitized line segment along the U.S. Gulf Coast.

File Storage - ARC/INFO™ coverage name is GCLINE.E00 (File 12) ASCII file name is GCLINE.ASC (File 13).

Data Variables

ELAVG - Average elevation calculated from all positive 5' by 5' grid cells within a given 0.25° grid cell; values expressed in meters.

ELMAX - Maximum elevation of all the positive 5' by 5' grid cells for a given 0.25° grid cell; values expressed in meters.

ELMIN - Minimum elevation of all the positive 5' by 5' grid cells for a given 0.25° grid cell; values expressed in meters.

ELNUM - Number of 5' by 5' grid cells used in calculating ELAVG, ELMIN, and ELMAX for a given 0.25° grid cell.

ELR - Classified version of the mean elevation data variable (i.e., ELAVG).

GL - Ordinal value indicating the type and resistance of the rocks within a given 0.25° grid cell to erosion through physical and chemical weathering.

GLR - Classified version of the geology data variable (i.e., GL).

GM - Ordinal value indicating the type and susceptibility of the landforms within a given 0.25° grid cell to inundation and erosion.

GMR - Classified version of the geomorphology data variable (i.e., GM).

SLR - Relative sea level trend within a given 0.25° grid cell; values are expressed in mm/year. Data values are based on the point data in data group GCPOINT.

SLG - Geologic trend variable. In this data base this variable is 0.0. This data variable has been included to ensure compatibility between the data bases in this series of NDPs (i.e., NDP-043A, NDP-043B, and NDP-043C).

SLC - Corrected sea level trend derived from tide-gauge data (i.e., SLR) and corrected for geologic trends (i.e., SLG) for each 0.25° grid cell; values are expressed in mm/year. Data values are based on the point data in data group GCPOINT.

SLS - Local subsidence trend derived from tide-gauge data (i.e., SLR) and corrected for the global eustatic sea level trend (i.e., 1.5); values are expressed in mm/year. Data values are based on the point data in data group GCPOINT.

SLYR - Number of years of record used in estimating the sea level trend for each 0.25° grid cell (grid cells in which tide-gauge stations do not occur have been assigned a zero value.) Data values are based on the point data in data group GCPOINT.

LSR - Classified version of the local subsidence trend data variable (i.e., SLS).

ERAVG - Average of the mean long-term erosion trend values for a given 0.25° grid cell; values expressed in meters.

ERMAX - Maximum of the mean long-term erosion trends for a given 0.25° grid cell; values expressed in meters.

ERMIN - Minimum of the mean long-term erosion trends for a given 0.25° grid cell; values expressed in meters.

ERNUM - Number of 3', 7.5', or 15' grid cells (i.e., format of original data source) used in calculating ERAVG, ERMIN, or ERMAX for a given 0.25° grid cell.

ERR - Classified version of the mean erosion/accretion data variable (i.e., ERAVG).

TRAVG - Average of the mean-tide-range values for all tide stations occurring within a given 0.25° grid cell in 1988 (the mean tide range is the difference in height between mean high water and mean low water for 1988). Data values are expressed in meters and are based on the point data in data group GCPOINT.

TRMAX - Maximum tide range measured for all gauge stations that occurred within a given 0.25° grid cell in 1988 (this value may be the "spring" or "diurnal" tide range, depending on geographic location). Data values are expressed in meters and are based on the point data in data group GCPOINT.

TRLVL - Average of the mean-tide-level values for all tide stations occurring within a given 0.25° grid cell in 1988 (the mean tide level is a plane midway between mean low water and mean high water in 1988). Values are reckoned from chart datum, are expressed in meters, and are based on the point data in data group GCPOINT.

TRNUM - Number of tide-gauge stations used in calculating TRAVG, TRMAX, and TRLVL for a given 0.25° grid cell. Data values are based on the point data in data group GCPOINT.

TRR - Classified version of the mean-tide-range data variable (i.e., TRAVG).

WHAvg - 20-year mean wave height calculated for each 0.25° grid cell; values expressed in meters.

WHMAX - Maximum significant wave height for each 0.25° grid cell; values expressed in meters.

WHSD - Standard deviation of the mean wave heights experienced within each 0.25° grid cell; values expressed in meters.

WHR - Classified version of the maximum significant wave-height variable (i.e., WHMAX).

- (4) **Data Group GCPOINT:** Point data for the stations used in constructing the sea level trend and tidal range data sets. (Missing data values are indicated by the value 0.0 for real numbers, 0 for integers, and blank spaces [i.e., ' '] for station names.)

Data Format - ARC/INFO™ coverage and flat ASCII file with data values for each point (i.e., station) on the U.S. Gulf Coast.

File Storage - ARC/INFO™ coverage name is GCPOINT.E00 (File 16) ASCII file name is GCPOINT.ASC (File 17).

Data Variables

SLLONG - Longitude of the tide-gauge station used for determining the sea-level-trend variables.

SLLAT - Latitude of the given tide-gauge station used for determining the sea-level-trend variables.

SLR - Relative sea level trend for the tide-gauge station; values expressed in mm/year.

SLG - Geologic trend variable. In this data base this variable is 0.0. This data variable has been included to ensure compatibility between the data bases in this series of NDPs (i.e., NDP-043A, NDP-043B, and NDP-043C).

SLC - Corrected sea level trend derived from tide-gauge data (i.e., SLR) and corrected for geologic movements (i.e., SLG); values expressed in mm/year.

SLS - Local subsidence trend derived from tide-gauge data (i.e., SLR) and corrected for the global eustatic sea level trend (i.e., 1.5 mm/year); values are expressed in mm/year.

SLYR - Period of record in years of the tide-gauge station used for determining the sea-level-trend variables.

SLNAME - Station name of the tide-gauge station used for determining the sea level trend variables.

TRLONG - Longitude of the tide-gauge station used for determining the tide-range variables.

TRLAT - Latitude of the given tide-gauge station used for determining the tide-range variables.

TRAVG - Difference (i.e., range) in height between mean high water and mean low water in 1992; values expressed in meters.

TRMAX - Difference (i.e., range) in height between the highest high tide and the lowest low tide in 1992 (this value may be the "spring" or "diurnal" tide range, depending on geographic location); values expressed in meters.

TRLVL - Mean tide level is a plane midway between mean low water and mean high water in 1992; values expressed in meters. Values are reckoned from chart datums (i.e., the Gulf Coast Mean Low Water Datum).

TRID - Station number (as given in the 1992 Tide Tables) of the given tide gauge station used in determining the tide-range variables.

TRNAME - Station name (as given in the 1992 Tide Tables) of the given tide gauge station used in determining the tide-range variables.

- (5) **Auxiliary Data Group GCOAST:** 1:2,000,000 digitized coastline of the U.S. Gulf Coast.

Data Format - ARC/INFOTM coverage and flat ASCII file containing the latitude-longitude coordinates of line segments that describe the U.S. Gulf Coast.

File Storage - ARC/INFOTM coverage name is GCOAST.E00 (File 20) ASCII file name is GCOAST.ASC (File 21).

Data Variables

This data group contains an ARC/INFOTM coverage of line segments (or arcs) that are used to describe the Gulf Coast. This coastline does not contain the 29 data variables included within this NDP. Simple overlay commands (such as INTERSECT or IDENTITY) in ARC/INFOTM may be used to transfer the gridded data values to the coastal segments, thus simplifying the interpretation of any derived indices. This coverage was used as a base map for all the data sets within this data base.

APPENDIX B
GLOSSARY OF TERMS

Glossary of Terms Used in the Geologic Classification

What follows are a listing and definitions of the terms that appear in the geologic classification system shown in Table 1. The codes used in the classification system are shown in parentheses. When the classification number given contains an "X" (e.g., 1XX) it is implied that the definition is valid for all subsets of the given geologic feature. This list defines only those rock types mentioned within Table 1 and should not be construed as a comprehensive set of geologic definitions.

IGNEOUS ROCK (1XX) - Rock that has crystallized from a silicate melt at high temperatures (i.e., 900 to 1600°C).

VOLCANIC (EXTRUSIVE) ROCK (OLD=11X) (NEW=4XX) - Igneous rock that has reached the Earth's surface as a result of eruptive processes in a molten or partially molten state. Since these rocks tend to cool rapidly they are usually fine-grained.

ANDESITE (110) - Grayish fine-grained volcanic rock composed of oligoclase/andesine (plagioclase feldspar), with lesser amounts of hornblende, biotite, or pyroxene. Potassium feldspar and quartz compose less than 10% of the total mineral content (plutonic equivalent is quartz diorite).

BASALT (110) - Dark fine-grained volcanic rock consisting of labradorite (plagioclase feldspar) and augite (pyroxene), with minor olivine (plutonic equivalent is gabbro).

RHYOLITE (110) - Light fine-grained volcanic rock composed essentially of alkali feldspar and quartz, with minor biotite occasionally present (plutonic equivalent is granite).

PLUTONIC (INTRUSIVE) ROCK (13X) - Igneous rock which has crystallized from molten material (magma) at depth and has reached the Earth's surface through uplift and erosion. Because cooling is generally slower, these rocks are coarser-grained than their volcanic equivalents.

METAMORPHIC ROCK (15X) - Rock derived from preexisting materials (either igneous, sedimentary, or metamorphic) when recrystallization occurs under higher temperatures, pressures, and shear stresses than normally exist at the Earth's surface.

GNEISS (150) - Metamorphic rock that exhibits alternating bands of lighter minerals (quartz, feldspars) and darker minerals (biotite, hornblende, pyroxene).

QUARTZITE (150) - Metamorphic rock composed essentially of quartz. It results from high-grade metamorphism of a quartz-rich sandstone in which recrystallization of silica has produced a tough, hard rock with interlocking quartz grains.

SCHIST (150) - Metamorphic rock characterized by a layered or foliated appearance (schistosity) caused by the planar alignment of platy minerals, such as mica together with quartz, and minor amounts of other minerals, like garnet.

SERPENTINITE (150) - Green to greenish-yellow rock composed chiefly of the mineral serpentine, derived from metamorphism of iron-magnesium-rich igneous rocks.

SEDIMENTARY ROCK (2XX) - Rock consisting of weathered or eroded fragments of preexisting rocks that have been cemented together as a result of chemical cementation, compression, or precipitation.

SHALE (210) - Sedimentary rock consisting of very fine-grained particles (≤ 0.004 mm) composed chiefly of clay minerals. It is distinguished from mudstone, by its ability to split into thin layers.

SILTSTONE (220) - Sedimentary rock consisting of fine-grained particles in the size range of 0.004 to 0.062 mm. Composed chiefly of clays and fine-grained quartz with mica.

SANDSTONE (230) - Fine to medium-grained sedimentary rock with particles in the size range between 0.062 to 2.0 mm. Typically composed of quartz, feldspars, and rock fragments, which are cemented together by silica, calcite, iron oxide, or clay. The hardness or strength of this rock depends largely on the nature and extent of the cement.

CONGLOMERATE (240) - Coarse-grained sedimentary rock composed of boulders to granule-sized particles (> 2.0 mm), which are cemented together by silica, calcite, iron oxide, or clay. The hardness or strength of this rock depends largely on nature of the cement.

LIMESTONE (250) - Carbonate rock that can consist either of fragmental material, including fossils, pellets, etc., or a chemical precipitate.

EOLIANITE (260) - Layer of wind-blown beach sand often cemented by deposition of calcium carbonate. Tends to occur above the mean tide level in warm climates.

UNCONSOLIDATED SEDIMENTS (3XX) - Fragmented materials that are derived from the chemical and mechanical weathering process or from chemical precipitation and that have not yet undergone cementation and induration into a consolidated rock.

MUD, CLAY (310) - Very fine-grained particles (≤ 0.004 mm) of clay and quartz.

SILT (320) - Fine-grained particles (≤ 0.062 mm) of clay, quartz, and mica.

SAND (330) - Fine- to medium-grained particles (2.0 to 0.062 mm) of quartz, feldspar, other heavy minerals, and rock fragments.

GRAVELS, CONGLOMERATES (340) - Coarse-grained rock fragments (> 2.0 mm), usually rounded to some degree, depending on the amount of transportation before the fragments came to rest.

GLACIAL TILL (350) - Unsorted materials, ranging in size from fine-grained "rock flour" to large boulders, deposited by glaciers (also known as glacial drift).

CALCAREOUS SEDIMENT (360) - Very fine-grained to fine-grained carbonate sediment, which can be fragmental or chemically precipitated.

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LAVA (410) - Geologically recent volcanic rock that has formed by extrusion of molten magma to the Earth's surface as a sheet or flow.

ASH, TEPHRA (420) - Tephra is the general term for all fragmental volcanic materials ejected through a surface-reaching vent. Ash is unconsolidated, fine-grained ejected material (coarser-grained fragments are called bombs, scoria, pumice, etc.).

CORAL REEF (500) - Mass of calcareous material consisting of the skeletal structures of corals, growing in situ, as well as coralline debris and chemically precipitated material. Reefs are generally built of coral, but calcareous algae and shells contribute to the reef structure in many areas.

Glossary of Terms Used in the Geomorphologic Classification

What follows is a list of landform definitions and their associated classification values (shown in Table 2 on page 15). The terms are defined on the basis of the descriptions found in Bird (1984), Pethick (1984), Ritter (1986), Schwartz (1982), and Shepard and Wanless (1971). When the actual classification number contains an "X" (e.g., 222X) in the last digit, it is implied that the description is valid for all subsets of the given feature.

ALLUVIAL PLAIN SHORELINE (221X) - Intersection of broad alluvial slope, located at the base of a mountain range, with the ocean. These alluvial plains may also occur on delta coasts (222X) or outwash plains (231X).

BARRIER COASTS (212X) - In its most general sense, a barrier refers to accumulations of sand or gravel lying above high tide along a coast. These barriers may be partially or fully detached from the mainland. A barrier beach (2121) is a narrow strip of beach with a single ridge and often foredunes. A barrier island (2122) is completely surrounded by water and usually has multiple ridges, dunes, and salt marshes on the landward side of the island. It usually encloses a body of water known as a lagoon. Although barrier islands are the most common feature off the U.S. East and Gulf Coasts, they constitute 10% - 15% of the rest of the world's shorelines. A bay barrier (2123) is a beach barrier built across an embayment and is found in areas with low tide ranges, and high to moderate wave energies.

BEACH (21XX) - A beach is generally made up of sand, cobbles, or boulders and is defined as the portion of the coastal area that is directly affected by wave action and that is terminated inland by a sea cliff, a dune field, or the presence of permanent vegetation and seaward at the breaker/plunge point (the active portion of this zone varies based on wave and tide conditions).

BEACH ROCK (2112) - Cementation of beach sand by CaCO_3 in intertidal zones. Confined to warm climates.

CLIFFED COASTS (11XX) - Coasts with cliffs and other abrupt changes in slope at the ocean land interface. Cliffs indicate marine erosion and imply that the sediment supply of the given coastal segment is low. The cliffs height depends upon the topography of the hinterland, lithology of the area, and climate.

COASTAL PLAIN (211X) - Sedimentary deposits formed on a trailing-edge coast. Trailing-edge coasts are often associated with barrier beach systems and are commonly subject to subsidence.

CORAL REEF COASTS (241X, 242X) - Shoal water area built up by secretions of CaCO_3 by coral, marine algae, and other marine organisms. Reefs may form either fringing reefs that surround the shore or barrier reefs that grow at some distance from the coast and protect the coast from large waves.

CUSPATE FORELAND (2126) - Seaward projection of accumulated unconsolidated marine sand or gravel, bounded on both sides by wave-dominated coasts (indicates convergence of currents in a low-tide environment).

DELTA (222X) - Accumulations of fine-grained sedimentary deposits at the mouth of a river. The sediment is accumulating faster than wave erosion and subsidence can remove it. These are associated with mud flats (2224) and salt marshes (2225).

DROWNED KARST (1500) - Terrain with distinctive characteristics of relief and drainage arising from a high degree of rock solubility that was submerged at the end of the Wisconsin glaciation period (i.e., geologic substrate that is made of highly soluble, usually carbonate, rock).

ESTUARY COAST (133X) - Tidal mouth of a river or submerged river valley. Often defined to include any semi-enclosed coastal body of water diluted by freshwater, thus includes most bays. The estuaries are subjected to tidal influences with sedimentation rates and tidal ranges such that deltaic accumulations are absent. Also, estuaries are associated with relatively low-lying hinterlands, mud flats (1334), and salt marshes (1335).

FJORD (122X) - Narrow steep-walled, U-shaped, partially submerged glacial valley.

FIARD (123X) - Glacially eroded inlet located on low-lying rocky coasts (other terms used include sea inlets, fjardur, and firth).

ICE COAST (1400) - Coast bordered by glaciers.

LAGOON (225X) - A shallow water body separated from the open sea by sand islands (e.g., barrier islands) or coral reefs.

MANGROVE SWAMP (245X) - Coasts with tree vegetation of subtropical/tropical origin located on muddy, peaty substrates. Occur in coastal regions with low wave energies that are located in tropical and subtropical climates (occupies same ecological niche as salt marsh in temperate zones).

MUD FLATS - Located in areas with fine-grained sediments at low ends of the intertidal zone and are exposed at low tide. Found in estuaries (1334), deltaic environments (2224), and areas with marine/fluvial deposits (2254).

OUTWASH PLAIN (231X) - A river deposition coast. Deposits are derived from meltwater from the front of a glacier. Grades from gravel near the glacier edge to sand farther away. Other types of glacial deposits include moraines (2320), composed of poorly sorted till, and drumlins (2330), hills sculpted by glaciers, that are composed of well-sorted till.

SALT MARSH - Salt-tolerant vegetation that colonizes the intertidal zones of estuaries (1335), deltas (2225), and lagoons (2255). Located on slightly higher elevations than mud flats, and vegetation zonation reflects subtle changes in elevation.

SPIT (2127) - Curved or hooked depositional feature formed by longshore drift. Often has salt marshes on landward side and beach ridges marking former positions of the shoreline. Very mobile landform.

VOLCANIC COASTS (25XX) - Coasts dominated by volcanic landforms. The coasts may be built up of lava flows (251X), ash flows (252X), peninsular and island volcanoes, or calderas (253X). Often may be flanked by coral reefs (241X) if the volcano has become submerged.

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APPENDIX C

DATA LISTING OF GEOLOGIC AND GEOMORPHIC DATA

**Data Listing of the Geologic and Geomorphic Data of Each Line
Segment that Occurred Within Each Coastal Grid Cell**

The geologic and geomorphic data contained within this data base were originally obtained for 1:2,000,000 digitized line segments. These line segments averaged 6.9 km in length and when plotted are equivalent to those found in the line based data groups within this NDP. When gridded, more than one line segment often occurred within a coastal grid cell. When this situation occurred, the geologic or geomorphic code with the greatest total shorelength within the grid cell was assigned to the entire grid cell. For example, if grid cell number 396 contained two line segments, the first having geomorphic code 2255 and covering 36.86% of the shorelength within the grid cell and the other having geomorphic code 2450 and covering 63.14% of the total shore length within the grid cell, then geomorphic code 2450 was assigned to the grid cell, along with its corresponding risk value of 3.

To help the data user determine how this selection process may have affected the gridded data, the following tables were constructed. The first table illustrates the geologic data. It contains the identification number of each coastal grid cell, the assigned geology code, the actual shorelength in meters of each occurring geologic code, the percent of shoreline with the occurring geologic code, and the risk value corresponding to the geologic code (see Table 1, page 13, for definitions of each geologic classification code, and Table 4, page 27 for relative risk value assignments). The second table illustrates the geomorphic data. It contains the identification number of each coastal grid cell, the assigned geomorphic code, the actual shorelength in meters of each occurring geomorphic code, the percent of shoreline with the occurring geomorphic code, and the corresponding risk value (see Table 2, pages 16-17 for definitions of each geomorphic code and Table 5, page 27 for relative risk assignments).

Geologic Data

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
396	250	43059.77	100.00	3
397	250	73766.61	100.00	3
398	250	91952.12	100.00	3
399	250	29735.26	100.00	3
476	250	83410.70	76.14	3
476	370	26133.14	23.86	4
477	250	41405.20	100.00	3
555	370	42724.76	100.00	4
556	370	136541.54	100.00	4
571	370	13871.17	100.00	4
572	370	12420.95	100.00	4
633	330	1399.24	100.00	5
634	250	25512.03	15.04	3
634	330	64211.83	37.85	5
634	370	79936.71	47.12	4

Geologic Data (continued)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
635	370	116052.52	100.00	4
636	370	4666.49	100.00	4
651	310	15162.84	19.93	5
651	320	26093.85	34.30	5
651	370	34811.08	45.76	4
652	310	24897.20	25.99	5
652	330	20297.60	21.19	5
652	370	50615.77	52.83	4
713	250	35766.89	49.80	3
713	330	36047.26	50.20	5
714	250	16531.81	93.80	3
714	330	1093.08	6.20	5
730	370	1602.16	100.00	4
731	310	17155.60	11.01	5
731	330	2910.43	1.87	5
731	370	135723.05	87.12	4
732	310	27149.85	51.62	5
732	330	25449.26	48.38	5
792	250	13300.54	21.92	3
792	330	47371.23	78.08	5
793	250	58588.41	55.25	3
793	330	47446.64	44.75	5
810	370	410.79	100.00	4
811	310	84205.93	53.10	5
811	330	51377.97	32.40	5
811	370	23004.04	14.51	4
871	330	11593.94	100.00	5
872	250	142952.64	74.54	3
872	330	48820.96	25.46	5
873	250	17029.64	22.49	3
873	310	58681.53	77.51	5
890	330	1396.53	2.14	5
890	370	63871.72	97.86	4
891	310	39812.43	34.31	5
891	330	44892.77	38.68	5
891	370	31347.55	27.01	4
951	330	62157.52	58.65	5
951	370	43830.73	41.35	4
952	250	22754.95	15.80	3
952	370	121297.88	84.20	4
953	370	7852.89	100.00	4
970	320	15781.04	58.64	5
970	330	5329.67	19.80	5
970	370	5802.72	21.56	4

Geologic Data (continued)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
971	310	24803.49	18.90	5
971	330	70098.27	53.42	5
971	370	36310.72	27.67	4
1030	330	11406.63	55.56	5
1030	370	9124.45	44.44	4
1031	330	23638.03	65.59	5
1031	370	12400.48	34.41	4
1032	370	1096.40	100.00	4
1033	370	12893.22	100.00	4
1049	320	9243.59	43.53	5
1049	370	11989.50	56.47	4
1050	320	65748.52	28.94	5
1050	370	161470.98	71.06	4
1051	320	32611.60	21.30	5
1051	330	109984.79	71.83	5
1051	370	10530.01	6.88	4
1110	330	42632.62	35.16	5
1110	370	78623.94	64.84	4
1111	370	4618.23	100.00	4
1130	370	7819.86	100.00	4
1131	330	63264.48	64.84	5
1131	370	34303.81	35.16	4
1132	330	61465.18	100.00	5
1189	330	6877.12	100.00	5
1190	330	62978.97	31.52	5
1190	370	136834.44	68.48	4
1191	370	44057.25	100.00	4
1210	370	6463.65	100.00	4
1211	370	60570.12	100.00	4
1212	330	161870.94	94.36	5
1212	370	9672.44	5.64	4
1213	330	26589.51	100.00	5
1269	250	15584.66	16.73	3
1269	330	58504.62	62.81	5
1269	370	19051.64	20.45	4
1270	250	47871.91	35.45	3
1270	370	87156.40	64.55	4
1271	250	9964.21	14.66	3
1271	370	58023.48	85.34	4
1291	370	9852.69	100.00	4
1292	330	44515.96	35.91	5
1292	370	79461.53	64.09	4
1293	310	30149.02	17.61	5
1293	330	71081.47	41.53	5

Geologic Data (continued)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
1293	370	69925.09	40.85	4
1294	330	22686.38	55.59	5
1294	370	18127.20	44.41	4
1349	250	42564.19	58.92	3
1349	330	29674.67	41.08	5
1350	250	29336.95	100.00	3
1373	330	13481.60	23.28	5
1373	370	44423.25	76.72	4
1374	330	55364.40	40.21	5
1374	370	82323.56	59.79	4
1375	330	78684.07	60.26	5
1375	370	51896.97	39.74	4
1376	330	10670.45	100.00	5
1430	250	41276.98	100.00	3
1454	370	93950.98	100.00	4
1455	330	30292.28	22.88	5
1455	370	102082.62	77.12	4
1456	330	48528.57	36.35	5
1456	370	84960.03	63.65	4
1457	330	59506.94	64.63	5
1457	370	32568.19	35.37	4
1458	330	18654.53	65.25	5
1458	370	9933.82	34.75	4
1510	250	59490.31	100.00	3
1534	370	14539.23	100.00	4
1535	370	2119.68	100.00	4
1536	370	5385.08	100.00	4
1538	370	15840.82	100.00	4
1539	370	35938.56	100.00	4
1540	330	529.24	13.46	5
1540	370	3403.31	86.54	4
1563	370	34817.49	100.00	4
1564	370	2378.75	100.00	4
1589	250	1300.77	100.00	3
1590	250	104271.65	100.00	3
1619	370	8108.58	100.00	4
1620	330	39487.51	24.94	5
1620	370	118870.61	75.06	4
1621	330	16024.26	45.91	5
1621	370	18881.39	54.09	4
1636	370	67493.28	100.00	4
1637	330	39086.30	15.97	5
1637	370	205737.25	84.03	4
1638	330	34171.08	19.45	5

Geologic Data (continued)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
1638	370	141528.58	80.55	4
1639	330	49857.51	26.32	5
1639	370	139595.56	73.68	4
1640	330	9428.63	12.30	5
1640	370	67251.63	87.70	4
1641	330	6703.03	100.00	5
1642	370	4390.13	100.00	4
1642	370	140508.64	100.00	4
1644	370	200001.46	100.00	4
1645	370	2656.92	100.00	4
1668	250	48316.93	100.00	3
1669	250	66855.74	100.00	3
1670	250	3192.85	100.00	3
1700	370	4440.78	100.00	4
1701	330	24846.96	14.85	5
1701	370	142495.04	85.15	4
1702	330	31465.18	62.97	5
1702	370	18501.21	37.03	4
1713	370	17962.52	100.00	4
1715	370	41920.62	100.00	4
1716	370	140176.45	100.00	4
1717	370	87362.29	100.00	4
1718	370	71877.31	100.00	4
1719	370	100997.33	100.00	4
1720	370	184030.19	100.00	4
1721	330	35572.28	11.72	5
1721	370	268016.16	88.28	4
1722	330	13598.21	11.53	5
1722	370	104292.22	88.47	4
1723	370	88240.33	100.00	4
1724	330	13486.96	21.90	5
1724	370	48090.09	78.10	4
1747	250	18342.74	100.00	3
1748	250	55185.52	100.00	3
1780	370	43647.37	100.00	4
1781	330	13128.83	16.23	5
1781	370	67757.88	83.77	4
1782	330	2340.69	3.78	5
1782	370	59515.83	96.22	4
1783	330	6949.76	19.45	5
1783	370	28788.07	80.55	4
1784	370	25926.41	100.00	4
1785	370	43556.56	100.00	4
1788	370	6845.28	100.00	4

Geologic Data (continued)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
1789	370	26882.49	100.00	4
1790	370	25382.73	100.00	4
1791	370	24903.97	100.00	4
1792	370	99007.67	100.00	4
1793	370	72306.95	100.00	4
1794	370	59288.74	100.00	4
1795	370	76958.44	100.00	4
1800	370	106652.31	100.00	4
1801	370	28883.33	100.00	4
1802	370	351567.44	100.00	4
1803	370	75306.57	100.00	4
1804	330	25682.56	95.40	5
1804	370	1236.97	4.60	4
1805	330	27248.96	100.00	5
1819	330	33538.61	86.45	5
1819	370	5257.22	13.55	4
1820	330	43463.04	47.08	5
1820	370	48849.81	52.92	4
1821	330	57476.24	75.91	5
1821	370	18237.67	24.09	4
1822	330	12280.80	100.00	5
1826	250	7356.53	100.00	3
1827	250	43806.19	100.00	3
1860	370	36808.23	100.00	4
1861	370	9627.49	100.00	4
1862	370	14316.62	100.00	4
1865	370	86466.88	100.00	4
1866	370	26420.79	100.00	4
1867	370	28175.01	100.00	4
1868	370	18652.55	100.00	4
1872	370	26952.92	100.00	4
1873	370	50043.04	100.00	4
1874	370	24149.12	100.00	4
1880	370	29664.06	100.00	4
1881	370	48596.99	100.00	4
1882	370	111310.61	100.00	4
1883	370	449129.39	100.00	4
1884	370	61984.22	100.00	4
1885	330	104961.57	100.00	5
1898	330	9495.49	87.13	5
1898	370	1402.23	12.87	4
1899	330	34215.63	48.41	5
1899	370	36466.34	51.59	4
1901	370	43345.59	100.00	4

Geologic Data (continued)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
1902	330	29702.79	51.19	5
1902	370	28326.44	48.81	4
1903	250	5218.25	7.09	3
1903	330	20734.33	28.18	5
1903	370	47628.41	64.73	4
1905	250	13727.21	100.00	3
1906	250	37481.66	100.00	3
1960	370	16086.69	100.00	4
1961	370	56932.21	100.00	4
1962	370	84495.77	100.00	4
1963	370	200214.58	100.00	4
1964	330	31508.09	24.61	5
1964	370	96535.27	75.39	4
1965	330	31947.15	100.00	5
1966	330	43161.20	100.00	5
1967	330	37498.97	100.00	5
1968	330	28056.35	100.00	5
1969	330	37135.15	100.00	5
1970	330	4308.77	100.00	5
1977	330	24383.26	60.80	5
1977	370	15723.31	39.20	4
1978	330	37785.87	20.79	5
1978	370	143987.81	79.21	4
1979	370	50777.50	100.00	4
1983	250	44942.66	92.28	3
1983	370	3758.50	7.72	4
1984	250	47005.45	100.00	3
1985	250	30219.78	100.00	3
2043	370	50728.65	100.00	4
2044	330	2063.58	6.59	5
2044	370	29268.52	93.41	4
2045	370	86761.05	100.00	4
2046	330	3791.18	8.86	5
2046	370	39012.54	91.14	4
2047	370	72390.20	100.00	4
2048	330	37172.73	39.43	5
2048	370	57100.79	60.57	4
2049	330	18956.71	28.93	5
2049	370	46564.46	71.07	4
2050	330	87593.82	86.61	5
2050	370	13540.51	13.39	4
2051	330	76422.87	75.74	5
2051	370	24479.90	24.26	4

Geologic Data (concluded)

Grid cell number	Geologic code	Length (m)	Coastline percentage	Risk value
2052	330	49891.61	36.74	5
2052	370	85887.99	63.26	4
2053	330	49005.89	47.14	5
2053	370	54942.88	52.86	4
2054	330	59201.33	56.30	5
2054	370	45945.01	43.70	4
2055	330	45120.45	47.45	5
2055	370	49966.53	52.55	4
2056	330	25598.61	31.18	5
2056	370	56506.18	68.82	4
2057	330	7384.75	20.49	5
2057	370	28652.16	79.51	4
2058	370	58897.89	100.00	4
2128	370	81047.52	100.00	4
2129	370	60577.88	100.00	4
2132	370	58852.79	100.00	4
2133	370	10295.89	100.00	4
2135	370	17040.23	100.00	4
2136	370	1511.41	100.00	4
2208	370	4971.99	100.00	4
2209	370	24202.43	100.00	4

Geomorphic Data

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
396	2255	15873.83	36.86	3
396	2450	27185.93	63.14	3
397	2255	31519.97	42.73	3
397	2450	42246.64	57.27	3
398	2255	61326.11	66.69	3
398	2450	30626.01	33.31	3
399	2255	29735.26	100.00	3
476	2255	76852.02	70.16	3
476	2450	32691.82	29.84	3
477	2255	41405.20	100.00	3
555	9999	11933.92	27.93	0
555	2255	5239.46	12.26	3
555	2450	25551.38	59.80	3
556	9999	7859.48	5.76	0
556	2255	110057.28	80.60	3
556	2450	18624.78	13.64	3
571	2220	13871.17	100.00	5
572	2122	3238.61	26.07	5
572	2220	9182.34	73.93	5
633	2122	1399.24	100.00	5
634	2122	4050.41	2.39	5
634	2127	6821.96	4.02	5
634	2255	31123.87	18.34	3
634	2450	127664.34	75.25	3
635	9999	8374.12	7.22	0
635	2255	22994.18	19.81	3
635	2450	84684.22	72.97	3
636	2255	4666.49	100.00	3
651	2220	76067.78	100.00	5
652	2122	35380.72	36.93	5
652	2124	22688.22	23.68	5
652	2220	37741.62	39.39	5
713	9999	638.46	0.89	0
713	2121	27608.34	38.44	5
713	2122	23001.37	32.03	5
713	2255	20565.98	28.64	3
714	2122	1500.37	8.51	5
714	2255	16124.52	91.49	3
730	2250	511.90	31.95	4
730	2255	1090.26	68.05	3
731	2122	2910.43	1.87	5
731	2124	17155.60	11.01	5

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
731	2220	11596.32	7.44	5
731	2250	7593.32	4.87	4
731	2255	112726.90	72.36	3
732	2122	25449.26	48.38	5
732	2124	27149.85	51.62	5
792	1330	4300.89	7.09	4
792	2122	23371.17	38.52	5
792	2125	24000.06	39.56	3
792	2255	8999.65	14.83	3
793	1330	4624.67	4.36	4
793	2121	9087.55	8.57	5
793	2122	5588.23	5.27	5
793	2255	86734.60	81.80	3
810	2250	410.79	100.00	4
811	2122	28816.89	18.17	5
811	2124	84205.93	53.10	5
811	2127	13434.45	8.47	5
811	2250	32130.67	20.26	4
871	2122	11593.94	100.00	5
872	1330	4230.49	2.21	4
872	1335	2400.36	1.25	3
872	2122	33658.53	17.55	5
872	2125	7182.73	3.75	3
872	2250	4025.52	2.10	4
872	2255	140275.97	73.15	3
873	1330	27388.42	36.17	4
873	1335	39470.23	52.13	3
873	1339	8852.51	11.69	4
890	2250	65268.25	100.00	4
891	2122	27883.41	24.03	5
891	2124	40881.38	35.23	5
891	2250	47287.96	40.75	4
951	1330	17102.54	16.14	4
951	2121	47052.25	44.39	5
951	2122	15880.81	14.98	5
951	2250	21365.98	20.16	4
951	2255	4586.67	4.33	3
952	1330	49706.42	34.51	4
952	1339	20987.75	14.57	4
952	2122	10107.43	7.02	5
952	2250	2635.45	1.83	4
952	2255	60615.78	42.08	3

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
953	1330	4982.36	63.45	4
953	1339	2870.53	36.55	4
970	1330	21110.71	78.44	4
970	2250	5802.72	21.56	4
971	1330	1487.09	1.13	4
971	2122	34550.07	26.33	5
971	2124	24803.49	18.90	5
971	2250	70371.83	53.63	4
1030	2121	15342.05	74.73	5
1030	2250	5189.02	25.27	4
1031	1330	9367.30	25.99	4
1031	2120	7271.38	20.18	5
1031	2121	16366.65	45.41	5
1031	2250	3033.18	8.42	4
1032	1330	1096.40	100.00	4
1033	1330	12893.22	100.00	4
1049	1330	21233.09	100.00	4
1050	1330	227219.50	100.00	4
1051	1330	66448.85	43.39	4
1051	2120	21077.20	13.76	5
1051	2122	63897.24	41.73	5
1051	2250	1703.12	1.11	4
1110	1330	9133.23	7.53	4
1110	2121	45553.56	37.57	5
1110	2250	2131.59	1.76	4
1110	2255	48684.36	40.15	3
1110	9999	15754.01	12.99	0
1111	1330	4618.23	100.00	4
1130	1330	7819.86	100.00	4
1131	1330	38267.15	39.22	4
1131	2120	24282.82	24.89	5
1131	2122	19381.91	19.86	5
1131	2127	4031.46	4.13	5
1131	2250	11604.96	11.89	4
1132	2122	61465.18	100.00	5
1189	2122	6877.12	100.00	5
1190	1330	42978.88	21.51	4
1190	1335	39661.95	19.85	3
1190	1339	8881.70	4.44	4
1190	2121	5798.88	2.90	5
1190	2122	26183.72	13.10	5
1190	2127	15191.10	7.60	5
1190	2250	52460.40	26.25	4

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1190	2255	8656.79	4.33	3
1191	1330	19927.16	45.23	4
1191	1335	24130.09	54.77	3
1210	2225	6463.65	100.00	3
1211	1330	26243.30	43.33	4
1211	1339	9327.54	15.40	4
1211	2127	9741.37	16.08	5
1211	2225	2629.38	4.34	3
1211	2250	12628.53	20.85	4
1212	1330	12347.70	7.20	4
1212	2120	29595.24	17.25	5
1212	2122	76447.25	44.56	5
1212	2127	8031.97	4.68	5
1212	2250	45121.22	26.30	4
1213	2122	22782.88	85.68	5
1213	2124	3806.62	14.32	5
1269	1330	10838.86	11.64	4
1269	2122	44594.61	47.88	5
1269	2250	37707.45	40.48	4
1270	1330	24578.30	18.20	4
1270	1335	64044.34	47.43	3
1270	1339	41106.72	30.44	4
1270	2250	5298.95	3.92	4
1271	1330	30023.41	44.16	4
1271	1335	5206.87	7.66	3
1271	1339	32757.42	48.18	4
1291	1330	9852.69	100.00	4
1292	1330	103798.74	83.72	4
1292	2120	16832.48	13.58	5
1292	2250	3346.26	2.70	4
1293	1330	3138.85	1.83	4
1293	1335	41528.64	24.26	3
1293	2122	28061.22	16.40	5
1293	2124	61403.44	35.88	5
1293	2250	2816.62	1.65	4
1293	2255	34206.80	19.99	3
1294	2122	22686.38	55.59	5
1294	2124	18127.20	44.41	5
1349	1330	13388.39	18.53	4
1349	2122	29674.67	41.08	5
1349	2250	15266.87	21.13	4
1349	2450	13908.93	19.25	3
1350	1335	24625.92	83.94	3

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1350	2450	4711.03	16.06	3
1373	1330	55508.98	95.86	4
1373	1335	2395.87	4.14	3
1374	1330	46926.90	34.08	4
1374	2120	43427.51	31.54	5
1374	2122	7197.40	5.23	5
1374	2124	40136.14	29.15	5
1375	1330	4728.65	3.62	4
1375	2120	15988.20	12.24	5
1375	2122	46143.43	35.34	5
1375	2124	49625.05	38.00	5
1375	2255	14095.71	10.79	3
1376	2122	10670.45	100.00	5
1430	2450	41276.98	100.00	3
1454	1330	76422.13	81.34	4
1454	1339	17528.85	18.66	4
1455	1330	107434.19	81.16	4
1455	2120	24940.71	18.84	5
1456	1330	29956.59	22.44	4
1456	2121	28495.05	21.35	5
1456	2122	48528.57	36.35	5
1456	2220	547.03	0.41	5
1456	2250	25961.37	19.45	4
1457	2122	27903.11	30.30	5
1457	2125	22819.83	24.78	3
1457	2220	20118.84	21.85	5
1457	2255	21233.35	23.06	3
1458	2122	5711.10	19.98	5
1458	2125	11380.29	39.81	3
1458	2255	11496.96	40.22	3
1510	2450	59490.31	100.00	3
1534	1330	14539.23	100.00	4
1535	1330	2119.68	100.00	4
1536	1330	5385.08	100.00	4
1538	2125	14593.81	92.13	3
1538	2255	1247.01	7.87	3
1539	2121	6790.77	18.90	5
1539	2125	18812.09	52.35	3
1539	2220	10335.70	28.76	5
1540	2122	1771.32	45.04	5
1540	2125	2161.23	54.96	3
1563	2225	34817.49	100.00	3
1564	2225	2378.75	100.00	3

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1589	2450	1300.77	100.00	3
1590	1330	8785.06	8.43	4
1590	2450	95486.58	91.57	3
1619	1335	8108.58	100.00	3
1620	1335	52617.71	33.23	3
1620	2122	50961.66	32.18	5
1620	2125	13471.08	8.51	3
1620	2255	41307.67	26.08	3
1621	2122	32320.28	92.59	5
1621	2129	2585.37	7.41	5
1636	2225	67493.28	100.00	3
1637	2122	46898.70	19.16	5
1637	2225	197924.84	80.84	3
1638	2122	36516.20	20.78	5
1638	2225	139183.47	79.22	3
1639	2122	49857.51	26.32	5
1639	2225	139595.56	73.68	3
1640	2122	12089.62	15.77	5
1640	2225	64590.64	84.23	3
1641	2122	6703.03	100.00	5
1642	2225	4390.13	100.00	3
1643	2225	140508.64	100.00	3
1644	2225	200001.46	100.00	3
1645	2225	2656.92	100.00	3
1668	2410	28607.34	59.21	3
1668	2450	19709.59	40.79	3
1669	2450	66855.74	100.00	3
1670	2450	3192.85	100.00	3
1700	2255	4440.78	100.00	3
1701	1339	64530.82	38.56	4
1701	2120	7291.74	4.36	5
1701	2121	2920.60	1.75	5
1701	2122	54250.17	32.42	5
1701	2129	12020.62	7.18	5
1701	2255	26328.05	15.73	3
1702	2120	7050.66	14.11	5
1702	2121	27714.95	55.47	5
1702	2122	3750.23	7.51	5
1702	2125	11450.55	22.92	3
1713	2410	17962.52	100.00	3
1715	2225	41920.62	100.00	3
1716	2225	140176.45	100.00	3
1717	2225	87362.29	100.00	3

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1718	2225	71877.31	100.00	3
1719	2225	100997.33	100.00	3
1720	2225	184030.19	100.00	3
1721	2122	37649.83	12.40	5
1721	2225	265938.62	87.60	3
1722	2127	9281.29	7.87	5
1722	2225	108609.14	92.13	3
1723	2225	88240.33	100.00	3
1724	2122	13486.96	21.90	5
1724	2225	48090.09	78.10	3
1747	2450	18342.74	100.00	3
1748	2225	21678.26	39.28	3
1748	2450	33507.26	60.72	3
1780	1330	8950.48	20.51	4
1780	1339	34696.89	79.49	4
1781	1330	51295.39	63.42	4
1781	1335	8077.60	9.99	3
1781	1339	8254.95	10.21	4
1781	2125	5597.90	6.92	3
1781	9999	7660.86	9.47	0
1782	1330	11479.39	18.56	4
1782	1335	9376.73	15.16	3
1782	2121	1151.40	1.86	5
1782	2125	39849.00	64.42	3
1783	2110	23418.91	65.53	5
1783	2121	3213.26	8.99	5
1783	2125	9105.67	25.48	3
1784	2110	25926.41	100.00	5
1785	2110	16917.77	38.84	5
1785	2115	10443.68	23.98	3
1785	2250	16195.11	37.18	4
1788	2115	6845.28	100.00	3
1789	2115	26882.49	100.00	3
1790	2115	25382.73	100.00	3
1791	2115	24903.97	100.00	3
1792	2115	15075.02	15.23	3
1792	2225	80498.72	81.31	3
1792	2410	3433.94	3.47	3
1793	2225	55587.65	76.88	3
1793	2410	16719.30	23.12	3
1794	2225	59288.74	100.00	3
1795	2225	76958.44	100.00	3
1800	2225	106652.31	100.00	3

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1801	2225	28883.33	100.00	3
1802	2225	351567.44	100.00	3
1803	2225	75306.57	100.00	3
1804	2122	25682.56	95.40	5
1804	2225	1236.97	4.60	3
1805	2122	27248.96	100.00	5
1819	2120	5728.67	14.77	5
1819	2126	9409.51	24.25	5
1819	2127	17425.68	44.92	5
1819	2250	6231.98	16.06	4
1820	2122	33112.66	35.87	5
1820	2125	28280.91	30.64	3
1820	2127	5669.18	6.14	5
1820	2255	25250.11	27.35	3
1821	1335	6538.32	8.64	3
1821	2122	57476.24	75.91	5
1821	2225	8163.86	10.78	3
1821	2255	3535.50	4.67	3
1822	2122	12280.80	100.00	5
1826	2450	7356.53	100.00	3
1827	2450	43806.19	100.00	3
1860	1339	36808.23	100.00	4
1861	1330	598.01	6.21	4
1861	1335	9029.48	93.79	3
1862	1330	6979.41	48.75	4
1862	1335	7337.21	51.25	3
1865	2250	68487.57	79.21	4
1865	2259	17979.31	20.79	4
1866	2115	24637.79	93.25	3
1866	2250	1783.00	6.75	4
1867	2115	28175.01	100.00	3
1868	2115	18652.55	100.00	3
1872	2225	26952.92	100.00	3
1873	2225	50043.04	100.00	3
1874	2225	24149.12	100.00	3
1880	2229	29664.06	100.00	5
1881	2225	14220.72	29.26	3
1881	2229	34376.28	70.74	5
1882	2225	111310.61	100.00	3
1883	2225	449129.39	100.00	3
1884	2225	61984.22	100.00	3
1885	2122	104961.57	100.00	5
1898	2121	10897.72	100.00	5

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1899	2121	6159.07	8.71	5
1899	2127	30144.71	42.65	5
1899	2250	19385.09	27.43	4
1899	2450	14993.10	21.21	3
1901	1335	15780.81	36.41	3
1901	2225	16935.81	39.07	3
1901	2255	10628.97	24.52	3
1902	2122	29702.79	51.19	5
1902	2255	28326.44	48.81	3
1903	1330	17158.34	23.32	4
1903	2120	9115.16	12.39	5
1903	2127	21059.31	28.62	5
1903	2225	5201.02	7.07	3
1903	2255	16154.89	21.96	3
1903	2450	4892.28	6.65	3
1905	2450	13727.21	100.00	3
1906	2450	37481.66	100.00	3
1960	2229	16086.69	100.00	5
1961	2225	6935.60	12.18	3
1961	2229	49996.61	87.82	5
1962	2220	5768.76	6.83	5
1962	2225	8828.18	10.45	3
1962	2229	69898.83	82.72	5
1963	2220	17099.53	8.54	5
1963	2225	183115.05	91.46	3
1964	2122	31508.09	24.61	5
1964	2225	96535.27	75.39	3
1965	2122	31947.15	100.00	5
1966	2122	43161.20	100.00	5
1967	2122	37498.97	100.00	5
1968	2121	9541.13	34.01	5
1968	2122	18515.22	65.99	5
1969	2121	37135.15	100.00	5
1970	2121	4308.77	100.00	5
1977	2120	17216.16	42.93	5
1977	2121	7167.10	17.87	5
1977	2255	15723.31	39.20	3
1978	1330	18272.20	10.05	4
1978	2121	49726.40	27.36	5
1978	2122	19194.02	10.56	5
1978	2255	83803.61	46.10	3
1978	2259	10777.45	5.93	4

Geomorphic Data (continued)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
1979	1330	32444.98	63.90	4
1979	2255	18332.52	36.10	3
1983	1330	2094.92	4.30	4
1983	2225	1663.59	3.42	3
1983	2450	44942.66	92.28	3
1984	2450	47005.45	100.00	3
1985	2450	30219.78	100.00	3
2043	2119	7943.54	15.66	5
2043	2129	2216.20	4.37	5
2043	2220	4114.99	8.11	5
2043	2250	36453.93	71.86	4
2044	2122	2063.58	6.59	5
2044	2129	26744.57	85.36	5
2044	2250	2523.95	8.06	4
2045	2122	15402.37	17.75	5
2045	2129	15557.67	17.93	5
2045	2250	12635.68	14.56	4
2045	2255	19831.01	22.86	3
2045	2259	23334.32	26.89	4
2046	2122	9224.83	21.55	5
2046	2225	12655.62	29.57	3
2046	2255	14112.84	32.97	3
2046	2259	6810.43	15.91	4
2047	2255	72390.20	100.00	3
2048	1330	18657.44	19.79	4
2048	2122	37172.73	39.43	5
2048	2255	38443.35	40.78	3
2049	1335	54386.24	83.01	3
2049	2121	11134.94	16.99	5
2050	1335	78849.05	77.96	3
2050	2121	15137.89	14.97	5
2050	2122	7147.38	7.07	5
2051	1335	24350.11	24.13	3
2051	2122	52594.12	52.12	5
2051	2259	23958.54	23.74	4
2052	2122	71293.38	52.51	5
2052	2250	14581.83	10.74	4
2052	2255	23709.65	17.46	3
2052	2259	26194.74	19.29	4
2053	2122	61534.38	59.20	5
2053	2255	42414.39	40.80	3
2054	2121	942.61	0.90	5
2054	2122	53765.36	51.13	5

Geomorphic Data (concluded)

Grid cell number	Geomorphic code	Length (m)	Coastline percentage	Risk value
2054	2250	15298.30	14.55	4
2054	2255	13292.75	12.64	3
2054	2259	21847.32	20.78	4
2055	1330	7228.45	7.60	4
2055	2121	25003.20	26.30	5
2055	2250	2510.83	2.64	4
2055	2255	60344.50	63.46	3
2056	2120	12978.18	15.81	5
2056	2121	12620.43	15.37	5
2056	2255	56506.18	68.82	3
2057	2120	7384.75	20.49	5
2057	2255	28652.16	79.51	3
2058	1330	49114.45	83.39	4
2058	2255	9783.44	16.61	3
2128	1330	20441.53	25.22	4
2128	1339	45905.41	56.64	4
2128	2224	14700.58	18.14	5
2129	1330	14223.95	23.48	4
2129	1335	811.78	1.34	3
2129	1339	5527.65	9.12	4
2129	2224	40014.49	66.05	5
2132	1330	8848.92	15.04	4
2132	2225	9639.07	16.38	3
2132	2250	28530.87	48.48	4
2132	2255	3768.41	6.40	3
2132	2259	8065.52	13.70	4
2132	1330	2307.71	22.41	4
2133	1330	6750.29	65.56	3
2133	2225	1237.90	12.02	3
2133	2255	17040.23	100.00	4
2135	1330	1511.41	100.00	3
2136	2255	255.75	5.14	4
2208	1339	4716.24	94.86	5
2208	2224	24202.43	100.00	5
2209	2224			

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237. D. Alvic, EERC/UT, Pellissippi Office, Ste. 100, 10521 Research Drive, Knoxville, TN 37932
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- 280. A. L. Shumbera, National Oceanic and Atmospheric Administration, WDC-A for Meteorology, National Climatic Data Center, Federal Building MC E/CC, Asheville, NC 28801
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- 283. F. J. Wobber, Environmental Sciences Division, Office of Health and Environmental Research, Office of Energy Research, ER-74, U.S. Department of Energy, Washington, DC 20585
- 284. L. W. Wolf, National Research Council, Commission on Geosciences, Environment, and Resources, 2101 Constitution Avenue, Washington, DC 20418
- 285. Office of Assistant Manager for Energy Research and Development, U.S. Department of Energy Oak Ridge Operations, P. O. Box 2001, Oak Ridge, TN 37831-8600
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