Section Two
Social Sectors

Section Two of the Handbook refers to social sectors. It includes chapters describing methods for estimating the affected population, and damage to housing and human settlements, education and culture, and health. We begin by describing the evaluation methodology, offering practical examples to help the reader better understand and use the Handbook.

In Section Five of the Handbook, we discuss how to estimate effects on employment and income and the differential impact on women as part of comprehensive disaster analysis. Each chapter on individual sectors –whether social or economic– cites specific sources the specialist can use to obtain basic information needed for a complete, comprehensive analysis.

I. AFFECTED POPULATION

The quantitative expression of the size and characteristics of the population affected by a disaster is a central part of the assessment process. One of the first tasks of the specialist in social themes is to work closely with the other sectoral specialists in the assessment group to define the geographical area that has been affected. Then one must estimate the affected population, including the number of victims, the situation of the displaced population and the site of possible reconstruction activities.

Estimating the affected population –the one item where all intangible factors come together– is essential for attaining an overview of the disaster and assessing the damage and losses in each sector such as agriculture, health and housing. This population evaluation provides an independent measure against which the consistency of the rest of the estimates can be gauged, and it constitutes the starting point from which to direct all national and international relief efforts and to set priorities for rehabilitation and reconstruction plans.

1. Definition of affected geographical area and population

Disaster assessment must begin with a definition of the affected area. The dimensions and characteristics of the affected population should be determined immediately thereafter. If possible, an assessment should be made of the post-disaster situation in order to obtain an overall idea of the intangible deterioration (or improvement) of conditions governing the standard of living. The population specialists will have to use their own analytical criteria in choosing among the wide array of conflicting means for defining and measuring the affected population. It is generally useful to begin with a broad view of the affected area and population and then narrow it down.

The data most often used for such estimates are available in the most recent population and housing censuses, as well as in population estimates and projections derived from these and other sources, which can be found in official or academic publications. These data can be complemented by information from household surveys or by vital or administrative records.

A single procedure should be used to define the extent of the affected area, an exercise that should be completed before the assessment process for each sector is begun. Affected population estimates provide a common and essential reference point for later achieving a more precise damage assessment for each sector.

The strategy of choice for determining the affected population will depend on the kind of phenomenon that caused the disaster. (Examples of selection strategies are described in Appendix I.). Other factors influencing strategy choice include the availability of detailed and up-to-date census data or population projections; unforeseen demographic changes that might render such projections invalid ; and the time elapsed since the most recent census. The greater the time elapsed since the last census, the greater the number of necessary estimate assumptions and uncertainties regarding the validity of the projections. The more the census data is disaggregated, the more likely the estimates will be correct. Because of the need for a rapid assessment, one can take at face value any very recent census data, especially if no important pre-disaster demographic events have occurred in the area since the census, such as significant migratory flows and the emergence of new settlement areas.

The following are possible approaches based on two alternative scenarios:

(1) Annual population projections at a detailed (e.g., municipal) level are available, the disaster has occurred no more than five years after the most recent census, and there have been no important demographic changes in the affected area since the most recent census. In this case, once the geographical area has been defined (identification of the affected municipalities), the projected population for the year can be taken directly, or it can be estimated for the date of the disaster using the following exponential growth formula:

$$Pd = Po^{*}\ e^{rt} \qquad (1)$$

where:

Pd = the population on the day of the disaster;
Po = the most recent official estimate of the population;
r = the annual exponential growth rate for the year or period in which the disaster occurs; and
t = the length of time in years between the initial projection date used to calculate r and the time of the disaster.

Example: An assessment is made that a disaster that occurred on November 10, 2000, has affected 15 municipalities with a projected population of 3 590 000 on June 30, 2000 and 3 695 000 on June 30, 2001.

$$P_{10/11/2000} = P_{30/06/2000} * e^{rt}$$

The growth rate r can be calculated by applying formula (1):

$$r = [\ln (Pd/Po)]/t$$

$$r_{2000\text{-}2001} = [\ln(P_{30/06/2001} / P_{30/06/2000})] / 1$$

$$r_{2000\text{-}2001} = [\ln (3\,695\,000/3\,590\,000)] / 1$$

$$r_{2000\text{-}2001} = 0.02883$$

If

t = date of the disaster minus initial date of the population estimate
t = (November 11, 2000 – June 30, 2000)/365
t = (134)/365= 0.36712

then,

$$P_{10/11/2000} = P_{30/06/2000} * e^{rt}$$

$$P_{10/11/2000} = 3\,590\,000 * e^{0.02883*0.36712}$$

$$P_{10/11/2000} = 3\,628\,199$$

When significant changes have occurred in any of the affected areas (significant emigration or immigration flows before the disaster and after the census, for example), appropriate adjustments to the projected population figures and new projected totals must be made before undertaking the estimate shown above. Adjustments can be made by following the procedures shown in case (2). Once the new adjusted totals for the population of the affected area have been calculated, the procedure shown in (1) should be followed.

(2) The disaster has occurred five or more years after the most recent census, and, therefore, the projections at a disaggregated level may not be updated or do not exist. In this case, once the geographical area has been defined, either a projection of the population should be done or the available estimates should be analyzed to determine whether there is any evidence of municipalities whose population has increased or declined to a greater degree than that observed in the preceding inter-census period.

If there is no disaggregate population projection or if the existing one is out of date, it will be necessary to make a projection of the population in the affected area.

It is possible that projected information is available for a larger geographical area. In this case, the population of the affected area should be projected by applying the growth rate for the population of the department, province or state in which the area is located for the year or period that includes the date of the disaster.

Example: An estimate is required for the population of the area affected by a disaster that included 20 districts of Province X on January 15, 2001. According to the census taken on June 30, 2000, the corrected population figure for the area is 1 536 000. According to the department's own projections, the population of Province X will grow at a rate of 1.89 percent in the 2000–2005 period.

In this case, the estimated population of the affected area on the day of the disaster is calculated as shown below:

According to formula (1)

$$P_{15/01/2001} = P_{30/06/2000} * e^{0.0189*0.54110}$$

$$P_{15/01/2001} = 1\ 536\ 000 * e^{0.0189*0.54110}$$

$$P_{15/01/2001} = 1\ 551\ 789$$

In the previous example, it is assumed that no sudden demographic flows have occurred in the corresponding districts or municipalities, or that they were confined to displacement directly within the impact area. If this is not the case, it will be necessary to make separate projections for those municipalities or districts whose population growth or decline was greater than expected before continuing with the rest of the procedure. Additional sources of information (e.g., school rolls, new building permits and other administrative records) are necessary for such estimates, which involve specific methodologies.

The following two case studies demonstrate how to determine the affected geographical areas and population for two different disasters that occurred recently.

First case: In the case of an earthquake that occurred recently in a Central American country, there were conflicting versions as to the affected area and population. The population specialist made his or her own estimate by adopting the following procedure:

- To arrive at a broad initial estimate, the specialist marked on a map showing political and administrative divisions the geographical area where the population felt the earthquake, which registered V on the modified Mercalli intensity scale.

- The specialist then narrowed the area to include only those sections that reported victims or damage by reconciling official and unofficial partial data, figures obtained from an exhaustive study of press reports following the disaster and estimates gathered by visiting some of the affected areas.

- Some of the areas thus defined were virtually inaccessible, their population scattered or the latest census figures unreliable. The specialist then excluded those sections where only slight damage had been reported, and made "guesstimates" of damage in the remaining area (this was unavoidable given the limited time available to complete the assessment of damage).

- Census information was used as the basis for choosing the political-administrative unit with the most detailed population data. The area was thus defined, and the adjustments and projections needed to prepare a definitive estimate of the affected population were made.

Second case: In a similar case, where an earthquake affected a relatively inaccessible area of the Andes Mountains, it was necessary to determine the size and whereabouts of the population most affected by the disaster. The task was made more difficult because this was a rural area with a scattered population, and maps with current information about the population had not been located.

The following procedure was adopted:

- Information needed to identify the small, scattered population nuclei with sufficient accuracy was obtained from the cartographic bureau.

- By using this and other information related to material losses and the number of people affected, the population specialist was able to estimate the damage and the affected population in the hamlets, villages, and towns that were accessible by land. Information provided by teams sent to inspect nearby places (mainly to check the reliability and validity of the figures) made it possible to determine what percentage of the population had been severely affected in those localities. Although it was not feasible to visit large areas nearer to the epicenter, observations made in settlements with a concentrated population provided rough but clear evidence that as one got further away from the epicenter, the damage tended to diminish.

- With the resulting population data in hand, the specialist drew two concentric circles around the epicenter. The radius of the inner circle was the distance between the epicenter and the severely affected population centers furthest from it. The radius of the outer circle extended to the furthest population center in which the earthquake had been felt. Since the construction features of rural housing were also known, it was possible to estimate the size and location of the most severely affected population in the inner circle. Estimates of the total affected population (both urban and rural) were made on the basis of the population located within the circumference of the outer circle.

2. Software for accessing pre-disaster population data

a. General comments

As noted in the preceding paragraphs, the specialist must first define the affected area before estimating the varying degrees of population affectation. It is relatively easy to estimate the primary affected population by using available information about the number of people that are dead, wounded and housed in temporary shelters. To estimate the size of the remainder of the affected population (secondary and tertiary levels), baseline data on the total population living in the affected area at the time of the disaster is needed.

Once the disaster area has been defined, the sectoral teams work separately to gather and analyze information. Reports of deaths, injuries and shelter occupancy are the first field data on the primary affected population to become available. The analyst must then make estimates to compensate for holes in existing data on the pre-disaster population; here baseline information is essential. Population censuses (even when they were made well before the disaster) and household surveys (even if presented at less disaggregated geographical levels) may be used for this purpose. Detailed population data is generally more readily available when the affected area is very large (such as an entire region or province), but less accessible for smaller areas. In these cases, researchers should make use of computer software that is able to process population data from censuses and household surveys. A number of such software alternatives exist.

CELADE has developed and offers free of charge a programme called Redatam that can process population information from censuses and/or household surveys. Its ease of use and availability at no cost are advantages that cannot be overlooked. Furthermore, it has been tried and proven by ECLAC during several special assessment field missions.

Redatam G4 and its interface applications, such as R+G4xPlan, are designed to help generate population indicators from a variety of data sources. This facilitates decision-making at different geographical levels, from a country down to a municipality. The programme's features make it ideal for estimating the population and its characteristics in user-defined disaggregated areas, such as a set of districts added to another group of city blocks or rural sectors. Such a user-defined selection in combination with basic census or survey information can serve as a starting point for estimating the characteristics of the population and housing in these areas. These findings can be used to project population size. Alternatively, the increase in population up to the date of the disaster can be estimated using the methods mentioned earlier. This process is shown in Appendix III.

b. R+G4xPlan (pre-designed interfaces)

CELADE also makes available another Redatam-related tool. This is a Redatam interface known as RxPlan that makes it possible to use the database without needing to know how to use Redatam directly. This interface, which is very simple to create, can be generated before undertaking an assessment activity. It makes it possible to build modular applications tailored to the needs and specifications of the country and the disaster and to create predefined indicators (e.g., the number of households headed by women and the number headed by men; the number of unoccupied dwellings in comparison to occupied ones; the distribution of the affected population sorted by basic characteristics such as age, sex, marital status, education and employment) and to produce thematic maps.

Its interface consists of question forms or windows that produce output tables once a geographical area has been selected. It requires a census database in Redatam format and a map, if one is available.

This tool can assist in gathering information in a study of victims according to the optimum disaggregation level by considering the following items of information that should be obtained from data collected before and after the event:

- Total affected population (dead, wounded and those who have suffered material and economic loss);

- Disaggregation by age, sex and other basic characteristics; and

- Identification of high-risk categories (children under five, nursing mothers and pregnant women, the disabled or wounded and the aged).

3. Estimating the affected population

Since the population may be affected in different ways and to various degrees depending on the source of the disaster and the resulting damage and losses, we can break it down into primary, secondary and tertiary categories.

We thus establish a link between the affected population and the type of direct or indirect damage sustained, which may consist of lost capital or production or an increase in the cost of providing services. This link allows for a classification of the affected population in accordance with the three main components of total damage mentioned above.

a. Primary affected population

This category includes people affected by the direct effects of the disaster and consists of the dead, the injured and the disabled (primary trauma victims), as well as those who suffer material losses as a direct and immediate consequence of the disaster. This segment is made up of people who were in the affected area at the time the disaster occurred.

b. Secondary and tertiary affected population

These two types of affected population are defined as those segments of the population that suffer a disaster's indirect effects. The difference between the two groups is that the secondary affected population is located within or near the boundaries of the affected area, while the tertiary affected population usually resides outside or far away from the affected area.

Estimates of damages and losses sustained by secondary and tertiary affected population will be given by the sectoral assessments. Examples of the secondary affected population are the merchants in the affected area and people traditionally involved in marketing the lost crops, both of whom lose income as a result of the recessionary post-disaster environment. Examples of the tertiary affected population include people who have to assume the higher transport costs generated in the affected area, although they themselves live and work outside of it, and those who lose some benefits because public expenditure is reallocated to priority emergency activities.

In slowly evolving disasters, such as droughts or floods, secondarily affected people often take refuge in institutional or informal shelters. It is useful to keep a separate record of such people since their presence may provide an early warning of significant internal migration flows.

c. Assessing the direct and indirect effects on the population

Each sectoral assessment measures, in monetary terms, all direct damages and indirect losses sustained by the affected population. Damage to personal property is usually recorded in the housing sectors, while losses in production are included in the assessments of the productive sectors. Estimates of employment and income losses are made separately, as shown later in the Handbook.

The monetary loss due to deaths caused by a disaster may be high. From a methodological standpoint, it is possible to allocate a monetary value to such losses based on the victims' expected remaining period of useful life and the corresponding income that they would have earned, or based on life-insurance benefits. However, we do not engage in these estimates for two reasons. First, the purpose of this Handbook is to determine an amount of damage that can reflect the socio-economic impact of a disaster on the economic performance of an affected country or region. Second, using per capita earnings would result in the adoption of "second- or third-class" citizenship standards when comparing the victims with those in relatively more developed countries. In conclusion, loss of life is considered by ECLAC to be a permanent loss to society that cannot be substituted or recovered.

The most widely recognized effect on disaster victims is the deterioration in living standards. The physical environment is degraded, as are networks of social interaction whether they be on-the-job contact, communications systems, culture, and recreational activities; people begin to feel insecure and lose confidence in their way of life; access to education, health, and food is made more difficult; and the loss of homes and belongings reduces normal living standards.

Effects differ depending on the sex of the affected population: men generally sustain higher capital stock losses, while women usually end up facing increased reproductive workloads.

Other effects on the population –psychological harm and societal change, the solidarity or generosity shown in confronting the disaster, the despair of those who do not receive aid and many similar intangible costs or benefits– can only be estimated using indirect methods.

Disasters also produce psychological after-effects. Episodes of depression, anxiety, fatigue, nervousness, irritability, loss of appetite, modified sleep patterns and psychosomatic symptoms, such as diarrhea and headaches, have been observed and measured both during and after the emergency stage. Psychiatric interpretations of disaster effects suggest that damage of this nature may have significant short- and long-term effects. On the other hand, sociological research shows that while disasters produce significant stress, victims do not seem to behave in a dysfunctional way: profound pathologies are not common, psychological damage eventually disappears, and recovery is speedy.

The affected population's response mechanisms do not coincide with the alarmist version of events that dominates the media. Experience shows that victims tend to respond positively rather than panicking. Although cases of looting, plunder and social disruption have been observed in some cases, expressions of solidarity and support are the rule rather than the exception. Therefore, the population specialist should not try to estimate a probable cost for social disruption as a specific aspect of damage to victims.

Few events reveal societal inequalities better than the destruction caused by a disaster, especially in developing countries. The devastation suffered by the poorest people is so disproportionate that it becomes obvious where the cause lies: one is vulnerable because one is poor. These population strata are disproportionately affected by environmental degradation and the depletion of natural resources that are the basis of their urban and rural livelihood. In addition, inequalities among men and women become more acute. It is not unusual, therefore, for disasters to be followed by sweeping societal changes. To an even greater degree than intangible effects and psychological damage, the effects that cause societal change defy precise identification and measurement when making a quick damage assessment.

4. Estimating demographic effects after a disaster

Direct and indirect demographic effects of disasters are apparent in the components of population growth (mortality, fertility and migration), increased morbidity rates and/or the aggregate effect on population growth itself.

Direct effects on mortality rates refer to deaths that were an immediate consequence of the disaster and are included in the fatalities report. However, there are indirect effects on mortality rates that lead to loss of life in the short or medium term. In the short term, deaths, both in temporary shelters and elsewhere, may occur as a consequence of the increase in morbidity (such as acute respiratory ailments and infectious or parasitic diseases) caused by the disaster.

The deterioration in living conditions stemming from the disaster may still be felt in the medium term as a result of increased vulnerability and the deterioration of health, housing and basic-service infrastructure in general. The effects of a disaster on mortality and morbidity rates are determined in the health chapter of this Handbook. It is worth mentioning that the assistance provided after a disaster may have an indirect positive effect on the mortality rate if it brings about changes in health policy that improve the coverage and quality of services.

To estimate the specific demographic impact on the mortality rate by age and on the average life of the population, it is necessary to determine the age and sex structure of direct fatalities (and indirect ones, if feasible). Estimated life expectancy is calculated with the aid of a life table. The same table is then used to obtain a different average life expectancy figure by adding the additional fatalities caused by the disaster to each age and sex group. The difference between both is the number of years lost as a result of the disaster.

It is not as easy to calculate the indirect effects on fertility. The postponement or cancellation of marriages and a temporary drop in the frequency of sexual relations after a large-scale disaster or one with a long-lasting impact might lead to a short-term decline in the fertility rate. But there might be an effect whereby it recovers in the long term, as has been observed in the case of wars or other great crises. Sudden disasters, such as earthquakes or hurricanes, have substantial effects on the fertility rate only if the primary affected population is significant, thereby reducing the number of women of fertile age.

The link between cause and effect is very clear in the case of a disaster's impact on migration, but population specialists are likely to encounter difficulties in assessing the effects. Loss of property (land, homes, etc.) as a result of a disaster may lead to temporary population displacement. Other medium-term effects may be more significant. A change in production structure and in levels of employment may have a significant destabilizing effect. For many, this may create an opportunity to look for a new job or to emigrate, as was the case in the 1985 Mexico City earthquake. Since it is impossible to assess these impacts immediately after a disaster occurs, this analysis will have to be done later.

The full impact on demographic growth may be assessed only after the effects on the three previous components are known. Given the difficulties mentioned earlier in relation to fertility and migration, it will at least be possible to calculate a disaster's impact on demographic growth by taking loss of life into account. For example, if a disaster causes 200 deaths in an area whose population, in the year of the disaster, would normally have grown from 35 000 to 37 000 (that is an absolute growth of 2 000 people), it may be estimated that 10 percent (200/2 000) of the area's total growth failed to materialize as a result of the additional loss of life arising from the disaster.

Finally the effects on the elderly and the young must not be overlooked. These are especially vulnerable population groups that can be affected more intensively depending on the type or origin of any given disaster. A large impact on these groups may modify the prevailing demographic structure of the affected country, region or locality.

APPENDIX I

METHODOLOGIES FOR DETERMINING THE AFFECTED AREA ACCORDING TO THE TYPE OF NATURAL PHENOMENON

A. Seismic phenomena

Events

- Fault-line movements
- Tremors and earthquakes
- Liquefaction
- Tsunamis

Effects

Partial and total destruction of homes; large number of dead and wounded, especially those suffering fractures, as well as people left disabled or orphaned; an extended

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	********	********	********	********	********	********

Effects on the Environment

Effects	Air pollution	Water pollution	Land pollution
		Caused by overflows	Caused by overflows

reconstruction process requiring significant economic investment.

Basic Information to be collected

Location:

- Epicenter
- Geological information about the area

Intensity and magnitude of the phenomenon:

- The Mercalli scale measures the intensity of an earthquake according to the effects it has on people and property.

- The Richter scale measures magnitude, that is, the amount of energy released from an earthquake's epicenter as recorded on a seismograph.

History:

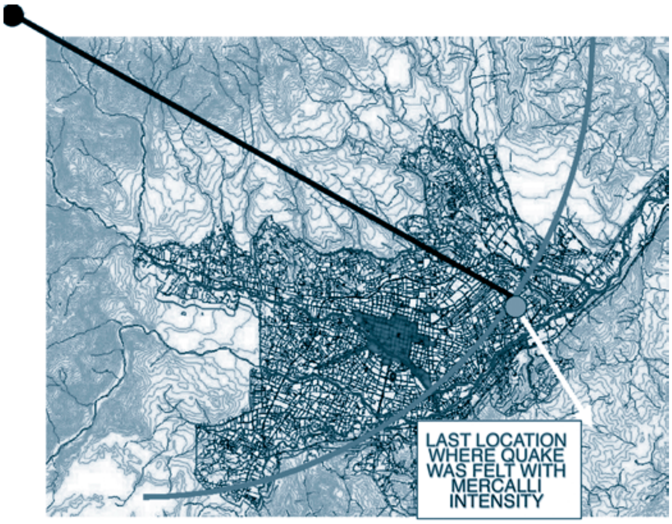
- Historical intervals between seismic phenomena

Determination of affected geographical area

One should use the epicenter as a reference point in defining the area affected by an earthquake. The study should be supported with as much relevant planimetric information as possible.

A circle is drawn with its center at the epicenter and its radius ending at the farthest point where the earthquake is known to have been felt at intensity V or greater on the Mercalli scale. This approximate representation of the affected area should be adjusted as more accurate information is obtained. The Mercalli scale may be used and more circles drawn to show affected areas that are more precisely tailored to the type of study to be carried out. For example, a smaller circle would be drawn for a study of physical damage to urban installations than for a study of the areas affected by interruptions in the supply of services. This means that areas where installations have been destroyed can be defined by a new circle whose radius is determined by the farthest place where physical structures are known to have been totally or partially destroyed (see figure 1).

Figure 1



Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. This basically shows in what part of the country the phenomenon took place.
- Regional level: 1:500,000 - 1:50,000. This level shows the location of the event and the entire affected area (both rural and urban) in greater detail.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are more commonly used in urban areas.

B. Atmospheric phenomena

Phenomenon
- Tropical storms and hurricanes
- Heavy rains
- Droughts

Consequences

The heavy rains and high winds produced by tropical storms, hurricanes and other atmospheric phenomena, such as the rainstorms that occur in Central America and the Caribbean, may cause considerable damage.

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	********	********	********	********	********	********

Effects on the Environment

Effects	Soil erosion and silting of river beds	Water pollution	Land pollution
	***************		

Abnormal periods, in which rainfall is reduced or the dry season gets longer, often occur in the region. They have a negative impact on agricultural production, power generation at hydroelectric plants and, at times, the supply of water for human and industrial use.

Basic information to be collected

Location:
- Geographical areas affected

Intensity:
- Rainfall
- Wind speed

History:
- Historical intervals between atmospheric phenomena

Determination of the affected geographical area

The best tools for identifying an area affected by a hurricane or similar meteorological phenomena, such as rainstorms, are satellite photographs, which can be obtained via the Internet. Photographs of this sort clearly define which areas have been affected day by day and make it possible to locate the key points in order to mark out the affected area.

Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. It basically shows in what part of the country the phenomenon took place. In the case of atmospheric phenomena, the scale often must cover several countries and indicate the phenomenon's path.
- Regional level: 1:500.000 - 1:50,000. This level shows the entire affected area (both rural and urban) in greater detail.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are more commonly used in urban areas.

C. Hydrological phenomena

Phenomenon

- River flooding
- Heavy seas
- Desertification
- Erosion

Consequences

This type of phenomenon will have different effects, depending on whether flooding takes place slowly or quickly.

- Slow evolution: minimal fatalities and injuries, damage to crops and both immediate and long-term effects on nutrition.
- Flash floods: many fatalities, few wounded, homes destroyed, immediate and long-term consequences for food.

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	********	********	********	********	********	********

Effects on the Environment

Effects	Air pollution	Water pollution	Land pollution
		******************	

Basic information to be collected

Location:

- Areas affected

Intensity:

- Rainfall
- Peak river flows
- Water volume
- Speed of movement

History:
- Historical intervals between hydrological phenomena

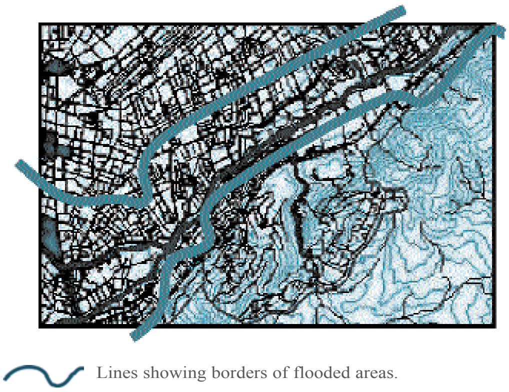
Determination of the affected area

There are two forms of measurement, depending on the type of flood:

- Floods caused by rain or storms can be measured by making a plan and establishing key points according to the information obtained (the triangulation method) or by examining the contours of the land, on the assumption that the lowest areas will be the most prone to flooding. These areas are also defined by geomorphic formations such as canyons.

- In the case of flooding caused by swollen rivers or tsunamis, the river's normal course or the beach line are taken as the base line. From there, parallel lines may be drawn, as reports arrive of affected areas (see figure 2). This information should be complemented with information about the sector's geographical conditions, such as contour lines, slopes, hills and so forth.

Figure 2
DEFINITION OF THE AREA AFFECTED BY FLOODING



Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. This basically shows the location of the event so that it can be seen in the context of the country where it occurred.
- Regional level: 1:500.000 - 1:50,000. This level shows the total affected area in greater detail and takes into account tributaries that might cause further floods later.
- Urban area level: 1:50,000- 1:2,500. These scales are used to prepare detailed plans of affected areas. They are generally used more in urban areas.

D. Volcanic phenomena

Phenomenon

- Rock ejections
- Pyroclastic eruptions
- Mudflows
- Lava flows
- Poison gas emissions
- Acid rain
- Pollution from toxic gases

Effects

Volcanic eruptions cause two kinds of direct damage, which may be found separately or together in a single event. However, the area affected by them can vary widely, depending on conditions such as wind and geographical agents.

- Damage caused by pyroclastic eruptions (the emission of ash and toxic gases into the air).
- Damage caused by lava flows.

Effects on urban infrastructure

- Fires
- Roofs collapsing under the weight of the ash
- Destruction caused by mudflows

Effects on health

- Injuries, broken bones, burns
- Worsening of respiratory ailments
- Bronchial irritation
- Asphyxia caused by inhalation of carbon dioxide
- Intoxication caused by hydrosulphuric acid and carbon monoxide

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupted
	********	********	********	********	********	********

Effects on the Environment

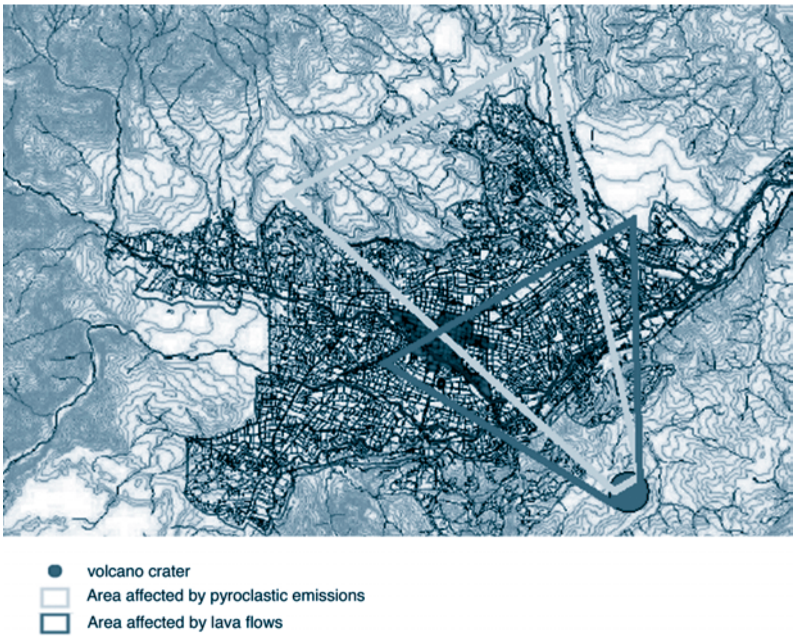
Effects	Air pollution	Water pollution	Soil pollution
	***************	*****************	*****************

Basic Information to be collected

- Location:
Location of the volcano and its relationship with its nearby surroundings

- Intensity:
Volume of ash emissions

- History:
Historical intervals between volcanic eruptions



Planimetrics - scales

- Country level: 1:1,000,000 - 1:250,000. This basically shows the location of the event so that it can be seen in the context of the country where it occurred.
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APPENDIX II

PROBLEMS RELATED TO AVAILABILITY AND USE OF INFORMATIONIN ASSESSING THE EFFECT OF DISASTERS

Specialists normally find it difficult to determine which information is the most reliable when they first embark on assessing a disaster. Not only is there often a lack of up-to-date information, but access may be limited, and information from different sources can be contradictory and of uneven quality depending on the variable and the geographical unit in question.

Some of these problems are described below and possible solutions to them proposed. We wish to emphasize that these are strategies for approaching the problems rather than specific solutions for all occasions.

Among the problems that are commonly found are the following:

- Difficulties in assessing the quality of basic information on fatalities and the number of other victims.

Information on the number of victims is often gathered by different organizations, and there is a risk of duplication. Also, there is a risk of overestimating the number of missing persons -which is often added to the number of fatalities- due to the challenge of adjusting figures when a person assumed to be missing is found. Another serious problem arises when estimating the number of people who have sustained losses. This figure can vary widely depending on when those living in shelters were counted.

A related problem that hinders future in-depth studies is the lack of information broken down by sex, age or other socio-economic variables.

In view of the above, we suggest reviewing and evaluating the estimated numbers of victims, including the dead, and obtaining as much information as possible regarding the demographic and socio-economic characteristics of the affected persons.

- Lack of consistency in data-gathering activities.

After a disaster, the institutions responsible for providing emergency assistance normally conduct surveys of the affected population. These are usually taken at shelters. Unfortunately, different methodologies are often used and the data are gathered on different dates, which means that the figures are not strictly comparable.

To avoid these complications, a single data-gathering activity should be coordinated as soon after the event as possible. Since this can be a time-consuming exercise, we recommend that it be conducted at shelters and that only a minimum of information be gathered. Questionnaires used in this type of survey often seek information that, although theoretically useful, is never analyzed. A basic set of questions should be designed to collect the following information:

- First name and surname(s)
- Sex
- Age
- Educational level
- Family members present in the shelter (e.g., father, mother, etc.)
- Sex and age of any family member who died
- Present state of health (e.g.,symptoms of acute respiratory problems, diarrhea or other contagious disease)
-Losses sustained by the family (e.g., house, domestic goods, farm animals, etc.)

- Availability of cartographic data.

The countries in the region are increasingly using digital cartography at an aggregate level and at the city and town levels, as well. When analyzing the effects of a disaster, use should be made of the most up-to-date maps available. In many cases, this information comes from the national statistics office or from cartographic organizations. Also, as a result of decentralization, many local authorities have developed their own geographical information systems, so they, too, may have up-to-date maps of the areas under their jurisdiction. Part of the disaster assessment process should be to determine which material is available and how up-to-date it is.

- Need for a data-gathering strategy to assess medium-term effects of disasters.

A detailed assessment of the indirect effects of disasters in the medium-term can only be made if there is a post-disaster strategy that makes it possible both to assess the progress of the reconstruction process and to determine, say, the patterns of post-disaster migration or the effects of the disaster and subsequent aid on living conditions.

APPENDIX III
ESTIMATING THE POPULATION OF AFFECTED AREAS WITH REDATAM

There are many software packages that professionals can use to quickly and easily process data taken from censuses and other sources, organizing it into hierarchical databases for any user-defined geographical area (such as a group of city blocks). One of these programmes, which was developed in-house by CELADE, is called Redatam. Its validity and usefulness has been tested during recent ECLAC assessment missions. The main features of Redatam+G4 are described below.

What can Redatam+G4 do?

It makes it possible to process information in very large compressed databases (created in Redatam+G4 format), such as population and agricultural censuses, household surveys, etc., which contain data on millions of people, housing units and homes. Consequently, a Redatam+G4 database normally contains micro-data, that is data or variables linked to individuals, housing units, homes or other information elements from which different tables can be generated for any geographical area previously defined by the user. This data is hierarchically organized for rapid access and processed to find specific results for defined geographical areas of interest.

New variables can be derived and tables and other statistical results processed rapidly using graphic interfaces, without the assistance of a programmer.

Example of Redatam+G4 in use

Information is needed on the age and sex of the people in an area that has been affected by a disaster.

The procedure for obtaining the required results is as follows (see figure 1):

1. Open the database dictionary (with levels and variables).

2. Create a geographical selection with the area to be analyzed. Select File/New/Selection from the main menu. Expand the area tree to display the areas to be selected and double click. Name the selection and save it.

3. Open the Statistical Process window by choosing the cross-reference variables option from the Statistical Process menu.

4. Use the mouse to select the variable to be processed from the Dictionary window.

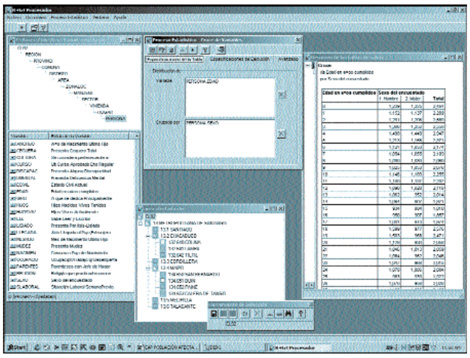
5. Select the name of the variable and drag it to the empty box in the process window.

6. Fill in the box(es) with the variable(s) to be processed, according to whether a frequency, cross-referencing of variables, or average is required.

7. Start the statistical process by clicking on the Start icon

Figure 1

REDATAM +G4 WINDOW WITH THE DICTIONARY, PROCESS, AND GEOGRPHICAL SELECTION DISPLAYED



R+G4xPlan (pre-designed interfaces)

The RxPlan tool provides controlled access to the information contained in a Redatam database. No understanding of its mechanism or internal operation is needed to use this tool, which provides an easy-to-use, user-friendly interface to access the information. Its operationality is commanded through the INL file.

An RxPlan can be loaded with information on the existing population before a mission to assess the impact of a disaster is started. This makes it possible to use the information in the field without having to be an expert in Redatam or other software.

Figure 2
Example of a plan with a population census (Panama)

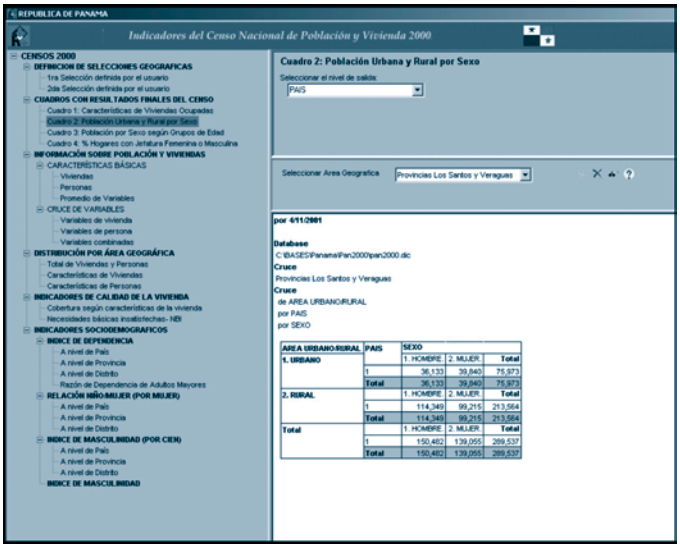
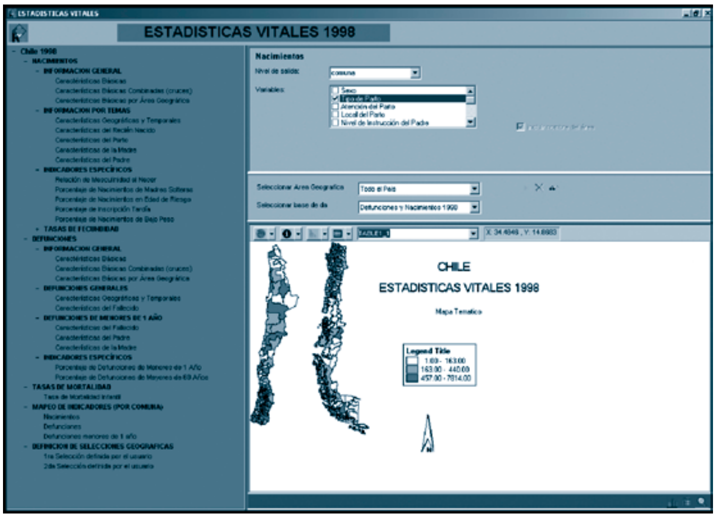


Figure 3
Example of a plan with vital statistics (Chile)



APPENDIX IV
THE USE OF GEOGRAPHICAL INFORMATION SYSTEM (GIS) TO ANALYZE INFORMATION GATHERED BY DIFFERENT SECTORS

A Geographical Information System (GIS) specifies a set of procedures in a non-graphic or descriptive database of real-world objects that can be represented graphically and whose dimensions can in some way be measured relative to the area of the world. Apart from a non-graphic specification, a GIS also has a graphic database of geo-referenced or spatial information, which is linked to the descriptive database. Information is considered geographical if it is measurable and has a location.

A GIS uses high-powered graphic and alphanumeric processing tools that are equipped with procedures and applications for inputting, storing, analyzing and visualizing geo-referenced information.

A GIS is useful mainly because of its capacity to build models or representations of the real world from information in databases. It achieves this by implementing a series of specific procedures that generate still more information for spatial analysis.

A valuable tool can be achieved by building simulation models that make it possible to establish the different influence factors by analyzing natural disasters or phenomena related to trends in time or space. GIS is therefore important for aiding hazard prevention and for simulating the damage that would be caused in the event of a natural disaster. GIS can also be used to interpret information by creating thematic maps that show the spatial distribution of the information. These maps show spatial patterns, trends or relationships, making it easier to analyze the information.

This is the case in the various successive stages of the process of assessing the damage caused by a disaster. The following possible uses of this tool are related to this point. A GIS makes it possible to modify the display of cartographic information by changing colors, symbols or values. This makes it possible to analyze the information from its spatial dimension in order to reveal patterns, relationships or trends.

A GIS is dynamic. Maps created with a GIS are not limited to just one moment in time. A map can be updated simply by updating the information linked to it. This operation is easy and quick and requires no special training.

Example:

THE JANUARY AND FEBRUARY 2001 EARTHQUAKES IN EL SALVADOR

Data gathered:

- According to the figures provided by El Salvador’s National Emergency Committee, in the housing sector, 222 773 housing units (18 percent of the country’s total stock of 1 259 697 urban and rural private housing units) were affected.

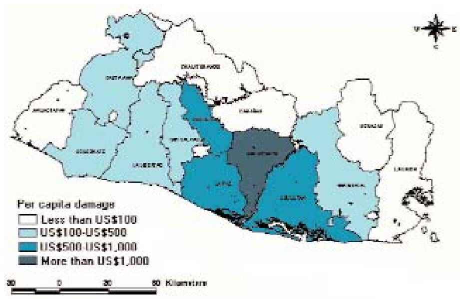
- Damage in the housing sector occurred throughout the country to differing degrees. The most affected provinces are Usulutan, (with 74% of housing damaged), San Vicente (with 69%) and La Paz (with 64%). In other affected provinces, such as Sonsonate, La Libertad, and Cuscatlan, figures of between 20 percent and 30 percent were recorded.

- Per capita damage varied from less than 100 US dollars to more than 1,000 US dollars.

Any of these data can be displayed on a map:

Map 1

GEOGRAPHICAL DISTRIBUTION OF EARTHQUAKE DAMAGE JANUARY - FEBRUARY 2001

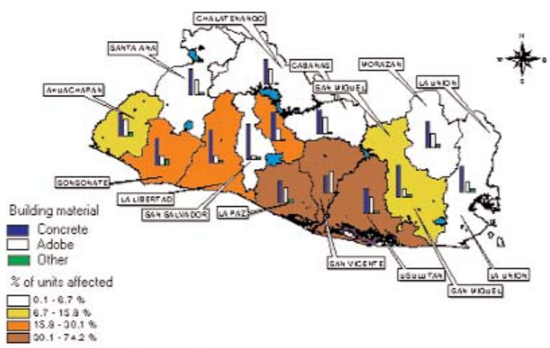


Source: ECLAC

With a GIS, different information can be fed into the same map. The mapping tools can then be used to modify the graphic representation to find spatial patterns and relationships, as shown in the following examples.

Map 2

IMPACT OF JANUARY 13, 2001 EARTHQUAKE
PERCENTAGE OF HOUSING UNITS DAMAGED BY DEPARTMENT
(Bar graph indicates breakdown by building material)

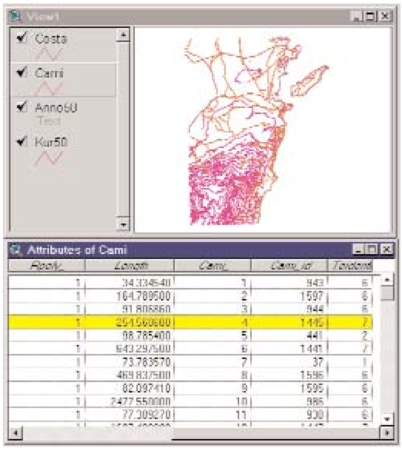


Source: COEN data at Feb. 2, 2001

Map 3
IMPACT OF EARTHQUAKES JANUARY - FEBRUARY 2001
SPATIAL DISTRIBUTION OF 2001 HUMAN DEVELOPMENT INDEX

A GEOGRAPHICAL DATABASE

A GIS maintains a database. The database concept is an essential part of a GIS and marks the main difference between it and simple drawing or computerized cartography software, which can only produce graphic information. Every modern GIS incorporates a database management system. This database may contain coverage, images, attribute tables, etc.



A GIS links the spatial data with descriptive information about some particular feature of a map. The information is stored as attributes or characteristics of the element that is represented graphically. For example, a road network may be represented by road centerlines, in which case a true visual representation would not provide much information about it. To obtain information about the road network, the user would consult the stored tabular data for roads, which might describe the class of roads, their width, type of surface, number of side roads, street names and ranking. The user can then create a display that represents all the roads according to the type of information required (see the following figure).

A GIS may also use stored attributes to calculate new information about a map's elements, such as the length of a given road or the total area of a particular kind of soil.

Users who want to go beyond mere drawing need to know three things about each element stored in the computer: what it is, where it is and how it is related to the other elements (for example, which roads are linked to form a road network).

Database systems deliver a means of storing a wide range of information and updating it without having to rewrite the programmes every time new data is input. In a GIS, the software handles the location of the elements, their descriptions and the way in which each characteristic is related to the rest.

A GIS allows the user to associate descriptive information with a map's elements, create new relationships that can be used to determine the layout of different sites for development, assess environmental impact, calculate crop volumes, identify the best location for new facilities, and so forth.

A GIS's capacity for data integration makes it possible to look at and analyze data in powerful new ways. Users can access information in a database table from a map or they can create maps based on the information in the table. For example, they can select a municipality on a map and display a list with all the relevant information about its population. Going the other way, users can also create a map of municipalities and display each of them according to the number of children, adults and seniors in their populations.

GIS COMPONENTS

A GIS has several components:

A GIS consists of hardware and software tools that use specific methods to perform operations on a database. The database is a simplification of the real world. The GIS user also becomes a vital part of the system when more sophisticated analyses are required. If queries about a place cannot be answered exclusively from the database screen, derived data may be required. Such derived databases are often the result of the effect of a model. A model is structured as a set of rules and procedures for deriving new information that can be analyzed by a tool such as a GIS and used to assist in problem - solving - and planning.

A GIS's analytical tools are used to build spatial models. The models may include a combination of logical expressions, mathematical procedures and criteria, which are used to simulate a process, predict an effect or imitate a phenomenon. Making the models calls for the tools found in a GIS, the ability to choose and use the right ones and great familiarity with the data being used. A GIS offers a great number of tools for analyzing the information in a spatial database.

When users wish to make a query or review a theme related to a spatial phenomenon, they can use a GIS to derive new information by creating a model that performs the analytical procedures. They can then examine the results from the model. This process, which is known as spatial analysis, is useful for evaluating suitability and capacity, estimating and predicting, and interpreting and understanding. There are many kinds of spatial analysis in a GIS, including contiguity analysis, proximity analysis, demarcation operations, surface analysis, network analysis and analysis based on the minimum element. These different forms of analysis include combined relational and spatial operations, as well as logical operations.

PROXIMITY ANALYSIS

How many houses are located less than 100 meters from a watercourse?
How many customers live within a 10 km radius of a given shop?
What percentage of alfalfa is within 500 meters of the silo?

To answer these questions, the GIS technology uses a process known as buffering, which determines the relationships of proximity between the elements (see the following figure).

LINKING ELEMENTS AND ATTRIBUTES

As mentioned above, the power of a GIS lies in the link between graphic (spatial) data and tabular (descriptive) data. Three are features noteworthy in this respect:

- A one-to-one relationship is conserved between the map elements and the records in the element attributes table.

- The link between element and record is conserved by a unique identifier assigned to each element.

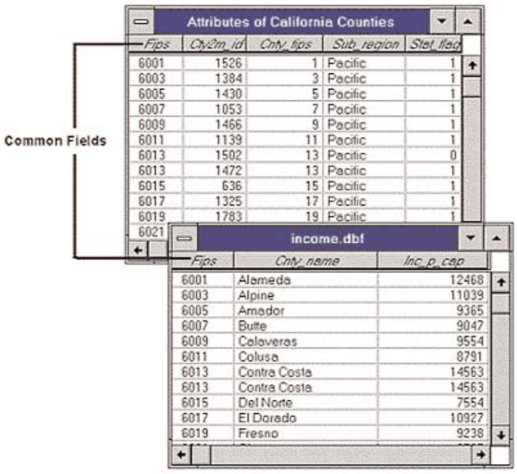
- The unique identifier is physically stored in two places: in the files containing the ordered pairs (x, y) and in the corresponding register in the element attributes table. A GIS automatically creates and conserves this connection.

Combined relational operations

In addition to keeping the elements and their attributes up to date, the previously described concept can be used for other functions. Either of the tables can be connected provided they share an attribute in common. A 'relationer' uses a common item to establish temporary connections between the corresponding registers in the two tables. In a relation, each record in one table is connected to a record in another table that shares the same value for an item in common. A relation has the effect of making a table of attributes 'larger' by temporarily adding attributes to it, which are not really stored there. An example of this can be seen in the following figure.

A relation temporarily connects two attributes tables by using the item they have in common.

In a GIS, a database that contains descriptive attributes can be joined to an element attributes table. If a relation is used, the file of related tabular data can be kept and updated separately. For example, the registers in tax files can be applied to a map showing plots of land, provided that each plot is identified with a unique number. Census data on land can be related with polygons using the number of plots of land contained in both.



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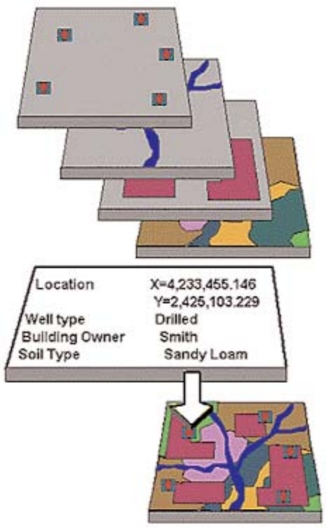
Combined spatial operations

Relations and unions are among the basic operations of a GIS. They are simple in concept and are often used. For example, when a spatial superimposition is created, each new output element has attributes from the two sets of input elements used to create it. The superimposition of polygons is essentially a spatial union. In this case, instead of using a common item from two tables, the records are paired on the basis of the location of their associated geographical elements.

In the figure below, a coverage layer of populated centers is combined with layers for the hydrographic system, zoning and relief. When these coverage layers are superimposed, the spatial information is combined, as are the attributes, and a combined coverage is produced.

The possibilities of a GIS are based on its ability to carry out the many kinds of spatial analysis needed to answer the wide range of questions that people might have. A GIS can carry out all these operations because it uses geography or space as the common key between the data sets. Information is related only if it refers to the same geographical area.



Like other information systems, a GIS confirms the saying that better information leads to better decisions. A GIS is not, however, an automated decision-making system. On the contrary, it is a tool for analyzing, querying and displaying geographical information that can be used to assist in decision - making. GIS technology is used to create scenarios that help us to make the best decision when solving a problem.

Finally, it is important to mention that the development of personal computers has now brought GIS technology within the reach of everybody. A GIS now makes it possible to perform complex, sophisticated spatial operations with a desktop computer.

QUESTIONS THAT A GIS CAN ANSWER

A simple GIS programme, such as ArcView©, MapInfo©, IDRISI© or GISMAP©, can be run on a PC to answer many of your location-related questions by making use of existing data.

The following are examples of typical questions that a GIS can help to answer.

Location: What exists in …?

The first of these questions attempts to discover what exists in a particular location. A location can be described in many ways, including place name, postal code or geographical references, such as latitude and longitude.

Condition: Where … ?

The second question is the opposite of the above and requires spatial analysis before it can be answered. Instead of identifying what exists at a given location, you may wish to find a place where certain conditions are met (for example, a non-forested piece of land with an area of at least 2,000 square meters, 100 meters from a road and with soil that is suitable for building).

Trends: What has changed since …?

The third question, which might include the first two, attempts to find differences within an area over a given period of time.

Patterns: What spatial patterns exist?

This question is a more complex . You might ask it to find out whether cancer is the leading cause of death among people living near a nuclear power station. Or you might want to know how many anomalies from a pattern there are and where they are located.

Creating models: What would happen if …?

This type of question is asked to find out things such as what would happen if a new road were added to a highway system or if a toxic substance were introduced into the underground water supply system. Specific geographical and other information is needed to answer this type of question.

The questions included when creating models call for the generation of additional data (using a complete GIS, such as ARC/INFO), based on existing geographical data. The following are some typical question-asking techniques.

Proximity: What are the characteristics of the area around the existing elements?

Provide a summary of the types of vegetation to be cleared within 100 meters of a fire cut-off for a high-voltage power line; inform the fire brigades about the nearest watercourse at the time of fighting a forest fire; notify the owners of wells within three miles of a toxic waste dumping site of possible pollution; warn all owners within 500 meters of a proposed change of site. All these problems can be solved with the proximity analysis tool: generation of intermediate memory areas or calculations of "intra-characteristic distance".

Limiting operations: What exists within a specific region?

Examine a problem, test a hypothesis and define alternative courses of action for the prototype areas in order to apply a model to an entire area of interest. You will sometimes wish to create data for specific areas of study. The limit operation tools can separate specific areas or they can extract elements from within a particular area.

Logical operations: What is unique for a region or a set of elements?

Examine soils with a particular alkalinity; study roads built with a specific kind of surface; study wells that are deeper than their design depth. The answers to some questions about spatial elements can be found in their tabular attributes rather than their location. Elements can be extracted from databases or introduced into them by using logical operations.

Spatial union: Where is something?

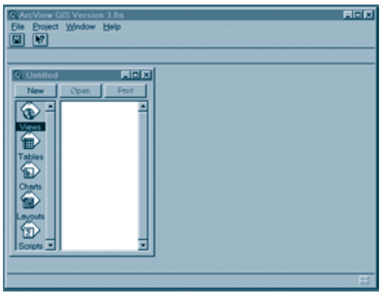
Establish area division discrepancies; establish wildlife habitat requirements; determine which parts of a right-of-way fall inside land whose ownership is in dispute. Many questions can be answered with spatial union operations, which are often referred to as the "superimposition of polygons". Spatial union operations provide new elements for the existing attributes.

NOTES ON USING ARCVIEW©

A spatial database may contain information about natural phenomena, artificial characteristics, limits, properties, etc. ArcView is a utility that creates an onscreen environment and queries the contents of a spatial database. ArcView allows users to explore the database, show all or part of its contents, query, display or save results and feed information to graphic and other applications.

THE ARCVIEW INTERFACE

The ArcView interface consists of windows, menus, a tool bar and a status bar. Like all programmes that run under Windows, ArcView is driven by menus that are activated by selecting options or clicking on icons. It is also extremely intuitive and user-friendly in its operating sequence.



ArcView's main window is the applications window. All ArcView operations are executed from there. This window can be resized, minimized and maximized with the mouse.

To load and display a coverage, an ArcView project must first be created, since every working session is saved in projects (file extension .apr). A project contains all the views, tables, graphics, cartographic compositions and macros that you need for a given application. This means that all your work is saved in the same place.

The projects window organizes and lists the contents of the active project and makes it easier to manage and control work. A new project will be named 'untitled' until given a new name. See left figure.

The tool bar is just below the menu bar. The icon buttons are used to activate given functions immediately without having to access them through a menu option. When the cursor passes over an icon on the tool bar, a description of its function appears in the bar at the bottom of the screen. At the start of an ArcView session, the main applications window contains only two buttons: one to save a project, the other to access the online help.

As you work with ArcView, the tool bars at the top of the screen change according to which window is active (a view, a table of attributes, graphics, etc.).

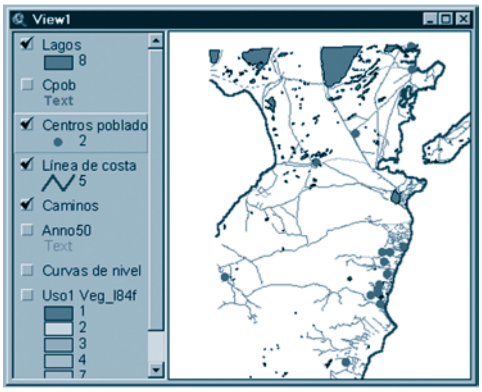
The following figure is a screenshot of several buttons grouped together. Each set of icons or buttons is used to activate different functions. For example, the tool bar in the second row beneath the main menu is used for operations that you might want to carry out on a map displayed in a view: request information about an element in the map, select an element, edit vertices, select a set of elements, zoom in and out, pan, measure, etc.

TYPES OF ARCVIEW DOCUMENTS

Boxes, tables, diagrams, schemes and macros handled in ArcView are known as documents. Each kind of document is briefly described below.

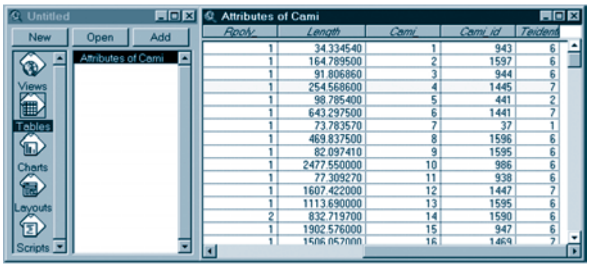
Views

A view is an interactive map that displays, explores, queries and analyzes geographical data. A view defines how the geographical data you are using will be displayed, but does not itself contain the geographical information.



A view can be thought of as a collection of themes. A theme is a collection of geographical phenomena defined by the user. The figure at right shows the view titled 'View 1', which shows the Punta Arenas sector in Region XII of Magallanes, Chile.

The view has a table of contents (or legend), which lists the themes being reviewed. The components of the view can be determined by looking at the table of contents. In the figure above, the window displays and lists the contents of the view.



Rpoly_	Length	Cami_	Cami_id	Teident
1	34.334540	1	943	6
1	164.789500	2	1597	6
1	91.806860	3	944	6
1	254.568600	4	1445	7
1	98.785400	5	441	2
1	643.297500	6	1441	7
1	73.783570	7	37	1
1	469.837500	8	1596	6
1	82.097410	9	1595	6
1	2477.550000	10	986	6
1	77.309270	11	938	6
1	1607.422000	12	1447	7
1	1113.690000	13	1595	6
2	832.719700	14	1590	6
1	1902.576000	15	947	6
1	1506.057000	16	1469	7

Table of Attributes

Tabular data are stored in a table. You can display, query and also analyze almost any kind of tabular data, such as geographical aspects, types of soil, road conditions and so forth.

Graphs

Graphs allow the user to show numerical information in a graphic form. A graph makes it possible to visually compare the behavior of one variable with that of another. ArcView provides several options for creating graphs that can accompany the display of attributes in a map

Cartographic compositions

Cartographic compositions allow users to locate every type of document in a single window and produce a final map. Instead of being copied directly, views, tables and maps can be referenced within a cartographic composition. In this way, changes to any of the elements are automatically reflected in the composition. You can add elements (titles, legends, bar scale, texts, arrow to indicate North, etc.) to the cartographic composition.

Macros

A macro is a set of commands written in the language known as Avenue that allows users to manage the database in ArcView transparently. You can use Avenue to design your own interface to access ArcView.

All documents are managed through the project control window. Each type of document is represented by an icon, which, when selected, will display a list of all the documents of this type contained in the project.

REPRESENTATION OF ELEMENTS ON THE MAP

Geographical phenomena are represented in the database by geometrical elements like polygons, lines, and points.

The geographical phenomena are known as classes of elements:

- Polygons might, for example, represent plots of land whose rateable value is within a certain range or parts of forests that contain particular species.

- Lines might represent paved roads, paths or drains of a specific diameter.

- Points might represent the location of warehouses, customers, wells or significant places.

AN ARC/INFO© COVERAGE

A coverage is a digital version of a map. It is the basic object that stores the geographical data (geographical elements and their attributes) in ARC/INFO©. A coverage may contain one or more classes of geographical elements. For example, a coverage whose elements are areas or polygons also contains labeled points that identify each polygon. In addition, a coverage containing polygons that represent plots of land may also contain linear elements (arcs) that contain information on the boundaries between the plots. When we add ARC/INFO© coverage to a view, the class of element to be used can be chosen.

ARCVIEW PROJECTS

A project is a space (with an .apr extension) that ArcView creates so that you can organize your work and documents in one place (or file). A project makes it easy to maintain and manage any combination of interrelated ArcView components. Views, tables, maps, cartographic compositions and macros can all be worked on and saved simultaneously in one file.

When you create an ArcView project, you create a file that contains the views, maps, plans and documents that make up the project.

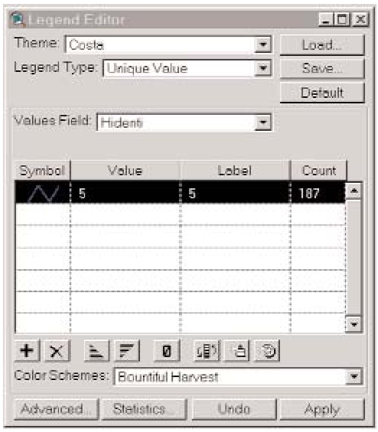
THEMES IN A VIEW

ArcView uses geographical information from a variety of databases to display a given geographical characteristic or theme in a view. Examples are spatial databases, including ARC/INFO coverage, configured ArcView files and satellite image data. ArcView also supports tabular (alphanumeric) databases that contain geographical information, such as street addresses and x,y coordinates.

The definition of the theme might simply be a request to display the complete database referred to in the theme, or it might be a set of criteria applied to the database to identify which part of the data should be displayed. A database is an ARC/INFO coverage or an image file. The image may have been scanned, or it may come from a satellite.

Themes can be given any name. A theme might be named according to the database to which it refers, such as, USENOW (present use of land), P3716 or COV143. It might also be named according to the criterion that it meets, as in, “Appropriate areas for development,” “Soil code = 5,” or “Model 2 results.”

Each theme represents a set of geographical elements that have a given characteristic or attribute. This characteristic or attribute is reflected cartographically by means of a determined symbology that is shown in a legend. A legend controls the way in which the elements in a theme are drawn. It consists of symbols, such as patterns that fill an area, types of lines that trace a linear feature or marks that show the specific location of a point (see right figure).



The symbols can be drawn with a great variety of colors. A theme can be displayed by using the same symbol and a different color or vice versa. For example, all the roads can be drawn with a broad red line or shopping centers can be represented with a yellow flag. ArcView provides a color palette for this purpose (see following figure).

Since themes are derived from a geographical database, they generally contain geographical elements associated with a table of attributes. All the elements of a theme can be drawn on the basis of a particular attribute value. For example, each water main can be drawn in a different color or with a different thickness according to its diameter if diameter is an attribute of the linear elements that represent pipelines.

Elements can be classified and then symbolized in accordance with the classification scheme, or each unique value for an attribute can be drawn. For example, types of soil can be shaded according to their alkalinity; regions can be colored according their net migration figures; or plots of land can be shaded with a unique pattern or color according to existing holdings.

As you get used to ArcView, you will learn how to use the table of contents to control which themes are visible. It is possible to display all or just some of the themes on one screen. You can also control the order in which the themes are displayed. Each theme points to a coverage stored in a database somewhere in the system. The data can be stored on a local disk or on a disk in a network. Although many themes can be derived from the same coverage, an individual theme can only refer to one attribute of that coverage.

Although a theme can contain only one class of element (polygon, line, point or text), it can be derived from a coverage that has more than one type of element. For example, a coverage formed by censused city blocks (polygons) and the fronts of each block (lines) has a topology for the polygons and the linear elements, but the theme based on this characteristic can only display one of them. Another theme can be created to display the attributes of the other class of element.

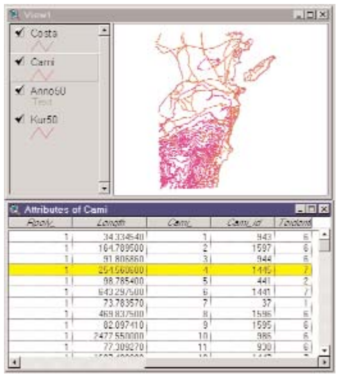


TABLE OF ATTRIBUTES

Spatial databases (e.g., ARC/INFO©) have a table of attributes associated with the geographical elements, which contains descriptive information. When a theme is displayed in a view, a table of attributes is immediately associated with the displayed elements (polygon, line, point or text).