MAPFRE RE
Madrid - SPAIN

I ERS THEMATIC WORKING GROUP MEETING ON FLOOD MONITORING

26-27 June 1995, Frascati, Italy.

OVERVIEW ON THE TECHNICAL NEEDS OF INSURANCE AND REINSURANCE COMPANIES, WITH AN EMPHASIS ON FLOOD RISK ASPECTS

Mª Teresa Piserra de Castro
Frascati, Italy - June 1995

CONTENTS

As a scientist working for the reinsurance industry, I think it is very wise of you to convoke providers, researchers and likely users of the satellite information with the aim of promoting a better knowledge of the possible applications and the availability to cope with the needs of the present world.

I have been asked to expose to you the point of view of the insurance and reinsurance industry in this context. First of all, I had to learn what kind of information can or could be provided by the satellites that might be useful for us. The recent launch of the ERS-2 and the previous ERS-1 have opened a wide range of information that before was only available after collecting huge amounts of data in many singular places of the world. Now, a complete view of the planet is easy with the puzzle of satellite photographs.

Natural catastrophes are one of the nightmares of insurers and reinsurers because of the immense loss potential in a matter of hours. We normally become involved in what it is called "catastrophe business" through the fire cover, which is normally bought by most of you for your homes, industries or small businesses. In most of the countries that are exposed to one or several natural hazards, the possibility of buying catastrophe cover against earthquake, flood, windstorm, volcanic eruption, tropical cyclone, etc, is offered.

Insurers are usually involved in a single country market, but most of the reinsurers take shares in many countries, as their main task is to "insure" the "insurer" and their aim is to spread the risk; the wider, the better. As natural events never take into account the international borders, it is very common that a loss scenario includes several countries where a reinsurer is involved.

Historically, insurers and reinsurers have estimated a PML, Probable Maximum Loss of their portfolios in an individual country or in the scenario loss area which consisted on a percentage of damages depending on:

- class of business (homeowners, industrial, commercial,..)
- type of building (year of construction, building code,..)
- maximum expected event
- geographical location

I imagine that the last two points must be familiar for you, because they could be the **intersection between satellite information and the insurers-reinsurers needs**.

1. MAXIMUM EXPECTED EVENT

Our memory is not as good as it should be. We often consider the maximum expected event as the last one we can remember. That is the case of the Mexican earthquake of 1985, the Chilean earthquake of 1985, the Northern Europe windstorms of 1990, the hurricane Andrew of 1992, the Los Angeles earthquake of 1994, the Kobe earthquake of 1995, etc. Insurance and reinsurance underwriters usually consider these as the biggest, until they realize that an even greater loss has been caused by a catastrophic event.

Good research has already been done by engineers, seismologists, geologists and architects in respect of earthquake vulnerability of structures. But whenever a new tremor trembles the Earth, a new focal mechanism or an unknown fault is discovered.

But the behavior of our atmosphere and its implications onto meteorology and climate, escape our control. The climate change, the effect of *El Niño*, the Ozone Hole and the Greenhouse effect are concepts that began to reach the normal people when a wave of strong wind events (Gilbert 1988, Hugo 1989, Northern Europe Windstorms 1990, Andrew 1992, Iñiki 1992) struck long distanced parts of the planet.

We are not always aware of the advance of Science, so once I have summarized for you, our stormy relationship with natural hazards, I will try to relate our needs with your facilities.

WHAT INFORMATION SUPPLIED BY THE SATELLITE CAN BE USEFUL FOR INSURERS AND REINSURERS?

Everything related to prevention, prediction, assessment of hazards and risks, monitoring and evaluation of losses. A very simple division could be made for those activities related to oceans, to the atmosphere and to the Earth and the possibilities of these risks being insured and reinsured:

➡ RELATED TO OCEANS

- Monitoring of iceberg tracks. Optimization of maritime routes Weather forecasting on the sea.

The possibility of collision with an iceberg must be avoided in commercial and transport maritime routes. Cargo, material damages, accident and life insurance are involved.

- Sea level changes.

Many coastal areas are threatened by a possible elevation of the sea level. Many small towns, big cities, agricultural areas, industries and ports can be inundated. Flood insurance is involved.

- Monitoring of oil spills.

The oil spill extension can be monitored continuously and so, it is possible to apply the suitable countermeasures to avoid or reduce material and ecological damages in the surrounding areas. Cargo insurance, material damages and contamination insurance are involved.

- Measurement of the height of waves.

The design of oil platforms as well as those tubes that conduct waste waters offshore, sometimes depends on the highest wave that can hit them. The simultaneous measuring of the height of waves during big storms on the sea can help to reach the correct standards of construction. Material damages, accident and life insurance are involved.

- Temperature of the sea water.

There is a well known oceanic area at tropical latitudes where the sea temperature can reach 27°C or more. This is a marvelous environment for the tropical cyclones to develop. If these areas are enlarged because of the climate change towards higher average temperatures, they should be carefully monitored to simulate new scenario loss areas. Insurance for wind and flood is offered in most of the tropical countries. The historical tracks give some guidelines to imagine the likely groups of countries that might be affected by a single event. More studies about return periods, likely intensities, landfalling hurricanes and tracks are required.

- Oceanic stream variations.

Coastal climates as well as fish production are greatly dependent on oceanic streams. Any change in the normal pattern should be detected in order to prevent negative consequences as much as possible. A northwards drift of the Kuro-shivo stream in the Pacific Ocean was observed some years ago. It usually carries warm and salty waters, as the Gulf Stream. There still remains the doubt whether the heavy rains of 1993 summer in Mississippi are related to this episode.

➡ RELATED TO THE ATMOSPHERE

- Hurricane tracks, wind direction and speed.

Once a tropical depression is formed, an accurate monitoring must be followed in order to organize the preventive measures in the threatened areas. Teams of insurance and reinsurance adjusters must get ready to visit the loss areas so that indemnizations can be agreed as soon as possible.

- Atmospheric temperature.

Some climate evolution models predict an increase in the average temperature in the Poles more important than in the Equator. This would probably disturb the existing air-flow patterns and the moderate climate we enjoy in these latitudes.

- Atmospheric pressure.

One of the procedures to detect a "El Niño" event is the different distribution of high and low pressure in New Zealand and India: during normal times, atmospheric pressure over the South Pacific is high, while the pressure above the Indian Ocean is low; this difference in pressure boosts the Monsoons. When this situation is inverted, no rain-carrying Monsoons materialize over India.

- CO_2 content.

The content of CO_2 in the atmosphere is increasing since the industrial revolution. The possible influence on the climate change

has to be proved. CO_2 is also expelled to the atmosphere by volcanoes.

- Water vapor content.

In general terms, high water vapor content combined with an increase in average temperatures, can contribute to trigger more precipitations and flooding, thunderstorms, hailstorms and also tornadoes.

➡ RELATED TO THE EARTH

- Accurate terrestrial orbit determination.

There are several theories that relate the periodical slight changes (millions of years time) in the orbit variation with ice ages and climate change. The accurate determination of the terrestrial orbit will be useful for future climate evolution predictions.

- Terrestrial surface minimal variations.

The monitoring of the pulse of the Earth will detect any modification on the surface as a consequence of internal volcanic activity. This swelling as well as magnetic, gravimetric and thermal anomalies, will contribute to allocate likely volcanic eruptions. Loss of lives and economic damages can be saved. Volcanic eruption insurance cover is involved.

Another application of the synthetic aperture radar (S.A.R.) could the control the subsidence caused by all means, such as isostatic uplift, weight of sediments, droughts (this happened in Great Britain some years ago and the insurance companies had to pay millions of pounds).

- Continental drift measurements.

Continental drift is mostly important in geological terms, but perhaps it is not essential for the daily life to know that the distance between Europe and America is increasing two centimeters every year because of the sea floor expansion. The theory of the constant radius of the Earth would say that two new centimeters in the Atlantic ocean plus the new nine centimeters of the Pacific ocean

created in the oceanic ridges would implicate that more oceanic crust should be consumed in the subduction zones. In general terms, this means more earthquakes, but perhaps it becomes science fiction. In any case, satellite images are useful to estimate the affected area after an earthquake. Earthquake insurance cover is involved.

- Crops prediction.

The consequences of the availability of predicting the quality of the crops are basic in the economic and social sense. For example, if is is possible to detect a *El Niño* event, several countries would be able to design a suitable cropping plan in respect of the rain that they will probably receive. Agricultural insurance is involved.

In respect of environmental problems, spaceborne remote sensing facilities will be able to detect the advance of desertification in several parts of the world.

- Tropical forests studies.

Tropical forests are usually covered by clouds, so that their study was difficult by means of aerial photographs. Satellites will provide data to allow suitable studies of the tropical areas.

- Bush and forest fires.

The location of fires in non populated areas as well as the estimation of damaged areas will be possible during bush and forest fires. Fire brigades and means would be ready to work as soon as the fire is identified and located.

- Land use planning.

The plan for land uses is designed with different data, such as topography, which can be provided by satellite photographs. Land use planning is essential for those areas that can be flooded. The correct use of soils and the suitable allocation of cities is elementary to prevent damages caused by floods.

- Floods prediction and loss evaluations.

My recent experience of the use of satellite data related to floods is summarized in the A.F.R.A.I.D. Project.

The presentation of the A.F.R.A.I.D. Project will take place in Rome the 27th of June of 1995 in the L.U.I.S.S. University of Rome. The acronym of the project was given by the scientists of Nuova TELESPAZIO, the space agency *per le telecomunicazioni spaziali*, who have played the main role in this joint venture. You might imagine that the insurers, reinsurers and brokers who have participated in the AFRAID project would never have chosen such a name, but it could be a lucky name for the project to be successful.

AFRAID means "A Flood Risk Analysis for Insurance Damages" and it is the result of a Consortium comprising an Italian insurance company Cattolica, the Italian reinsurance broker Ital Re, the European reinsurer and participated company of Mapfre Re C.I.A.R, Mapfre Re itself and Telespazio. The project has been developed by an interdisciplinary group composed of mathematicians, geologists, hydrologists and experts in computer design cartography.

Floods have already become a very important peril and risk in many parts of the world and especially in Europe and particularly in Italy. Although we could make a simple classification of the factors that characterize the causes and effects of floods in Northern Europe and in the Southern Mediterranean countries, the question is how to deal with them, how to face the consequences, how the rivers and rains behave and where they will accumulate.

The main tool of this study has been the data provided by the satellite photographs and remote sensing technologies that offer the facilities to manage all the selected data. Italy is completely digitalizated and so, the morphology of the river basins and the topography are absolutely controlled.

An additional difficulty is the scale of the study. The flood map will include the whole country, it will be based on a scientific map but it must be useful, accessible and user-friendly for the insurance and reinsurance underwriters.

That is why we have decided to design, firstly a map with a "pixel" as the minimal information unit with a resolution of a square kilometer, secondly a map of sub-basins of 200 to 300 square kilometers and finally, a map of flood hazard levels assigned to small provinces as the administrative division and useful unit. Anyway, this must be a decision of the insurance Italian market, as it will be the base of their accumulation control system for floods. As we are moving from pixel, to sub-basin and to province, we are loosing

quality in the information, but this is the only procedure that we have imagined.

We then had the Geographic Information Systems (G.I.S.), which allow the assignment of different data to every minimal information unit. This data would influence in the development of a flood, and summarizing, these have been chosen:

SLOPE, BASIN MORPHOLOGY, GEOLOGY, SOIL USES, DISTANCE TO THE NEAREST RIVER, MAXIMUM PRECIPITATIONS AND HISTORIC DATA.

All these are more or less easily available after a period of collection but the difficult step forward is how to mix them and interpret the result of the Flood Hazard Coefficient.

At present, the methodology has been applied to an individual river basin and it is being compared with other two. Our intention for the next 27th of June is to expose the methodology we have designed as a contribution to the knowledge of the behavior of floods. It could also be applied to other countries with the additional and necessary adaptations to every geographical area.

After summer and once the map is validated by all the interested parts, it is intended to print the final map with an additional memory which will detail the methodology applied .

➡ CORRELATION OCEAN - ATMOSPHERE - EARTH

- "El Niño" - Southern Oscillation (E.N.S.O.)

Somebody has called the Pacific as "the weather kitchen of the Globe" because of its great influence in the meteorology of all over the planet. Once it is identified, it is possible to predict its development for, at least, the following eighteen months, although the last one is lasting longer. Some of the direct effects of a El Niño event on insurance and reinsurance could be:

- ♦ Floods, windstorms and lightning can cause heavy damages on broadcasting equipment and transmission lines due to signal and reception interruption.

- Flash floods in arid and low-lying areas might cause erosion in foundations and collapse in tunnels or ditches for underground pipelines.
- Higher chances of rainfall or windstorm could lead to more cancellation of sports games, open air concerts and other outdoors events.
- Port and harbour installations are very vulnerable to storm surges, high tides, coastal flooding, erosion and severe hurricane. Docks and boats are also subject to damages due to warming waters and their increase in volume and height.

- Climate Change. Greenhouse effect.

The possible evolution of the climate towards an increase in the annual average temperature would accelerate the atmospheric heat engine, so that tropical cyclones, precipitations, flooding, thunderstorms, hailstorms and tornadoes would become more common and severe. This means that perhaps, not only the climatic conditions of the very well known countries that have been historically affected by all these phenomena will change, but also many new countries and areas will experience different catastrophic events. The first reaction of the population when suffering big losses from natural hazards is the growth in demand for insurance cover. The local insurance industry might react launching new policies without the technical and actuarial basis to develop a healthy portfolio, but their main problem is to find international reinsurance cover. After hurricane Andrew in 1992, there was a shortage of catastrophe reinsurance capacity, and this meant that international reinsurers were not interested in writing this kind of business for two reasons, among others:

- Insufficient premiums: these risks cannot be properly rated is there is not enough loss experience.
- The worrying predictions of the climate evolution during the following decades.

In spite of the pessimistic predictions, the reinsurer depends on the worldwide catastrophe capacity, never on the uncomfortable predicted future. It is a balance between supply and demand, the old story in every business.

In many countries, after the lack of international reinsurance capacity, the governmental institution in charge of the insurance

companies control (such as ANIA in Italy), have taken the initiative of creating a "pool of natural risks" following different schemes. In Spain, we have the Spanish Consortium of Insurance Compensation, which provides economic compensation for material damages caused by floods, earthquakes, windstorms, etc.

Should the private insurance and reinsurance industry or the governmental institution be responsible for the natural peril losses, a suitable technical and cartographic basis is fundamental.

2. GEOGRAPHIC INFORMATION SYSTEMS (G.I.S.)

Many businesses depend on geographic information. The development of insurance and reinsurance business is closely linked to geography. Here are some applications:

- Marketing strategies:
  - ♦ To plan the extension of portfolios to new areas where the competitors are already involved.
  - ♦ To analyze the suitability of a new product in respect of the characteristics (level of population, communication routes, standard of living) of an area.

    To plan the availability of assistance facilities (electricians, plumbers, hospitals, travel assistance) in case of loss or accident.

- Rating per zones: to analyze the suitability of tariffs in respect of different zones (cities-towns, natural hazards).

- Allocation of risks

  The underwriter of catastrophe business must have a suitable tool to allocate every risks he writes. Every risk has a sum insured for earthquake and/or flood and/or wind, etc. Every insured sum must be distributed into the reinsurance contracts. All this information must be managed over the geographic base.

- Evaluating catastrophe exposure.

The G.I.S. are a very interesting application for risk management. Because spreading risk is critical to any insurance-related strategy, it is important to

identify possible overexposure in those areas where any natural hazard is particularly high.

Once the hazards have been mapped, an overlapping with the portfolio will allow one to know the potential loss at any moment.

CONCLUSIONS

Summarizing, here are shown the weather conditions that might have direct and indirect influence in insurance and reinsurance:

Windstorms, Floods, Hail, Lightning, Droughts, Ice-Drift, Subsidence, Snow and Fog
IN
Agricultural, Homeowners, Industrial, Marine, Aviation, Engineering, Motor, Credit, Health and Life insurance

Independent of the traditional underwriting tools (charging a suitable price, deductibles, liability limits, improvement of claims settlement), the assessment of natural hazards can be considered as a triple problem:

- Risk and hazard evaluation and management.
- Knowledge of the phenomenon.
- Exposure modeling and accumulation control.

Disregarding the effects of a possible climate change, greenhouse effect and El Niño events, the statistics that are yearly published by the international reinsurers Munich Re and Swiss Re show a dramatic increase in losses due to natural disasters. The reasons that are usually attributed are:

- Increasing insurance demand and geographical density
- Improvement of standard of living
- Enormous concentrations of people and values in cities

- Rise in population
- Vulnerability of big cities
- Concentration of industrial businesses in areas exposed to natural hazards.

Insurers and reinsurers must prepare themselves for the increasing catastrophe risk, one way is the promotion of safety through lobbying for improvements in building codes in respect of natural forces, although the main role is played by market associations whose influence area is much wider. These usually publish brochures on different topics and provide the market with technical studies.

To demonstrate the important role of insurance and reinsurance industry to promote safety, just to remember that in April this year, the Climate Summit was celebrated in Berlin, during which, several European reinsurers made an important commitment, pledging to integrate environmental consideration into their business priorities. They will share environment-related information on a regular basis and at present, they are in process of drawing up a "Statement by the insurance sector on the environment and sustainable development", which will identify insurers´ commitments to environmental protection. This group will operate under the auspices of the United Nations Environment Programme (UNEP).

Let us hope that initiatives meetings like this and meeting like this, will promote a better understanding between scientists and the insurance-reinsurance industry.

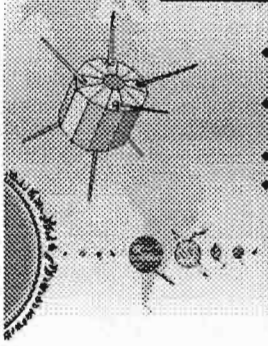
ERS Thematic Working Group Meeting
on Flood Monitoring. Frascati. Italy.

INSURANCE AND REINSURANCE

Overview on the technical needs, with an emphasis on flood risk aspects.

Mª Teresa Piserra de Castro

INTRODUCTION



- Data provided by ERS -1 and ERS -2.
- Natural catastrophes in insurance and reinsurance
- Relation insurer - reinsurer
- PML study:
  - class of business
  - type of building
  - maximum expected event
  - geographical location

MAXIMUM EXPECTED EVENT

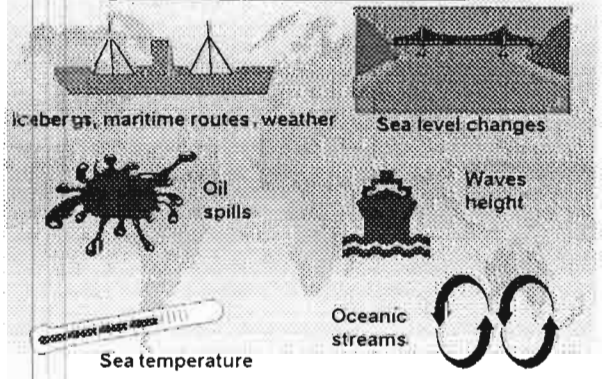
- ✓ **BAD MEMORY**
- ✓ **RESEARCH:** Earthquakes
  Atmosphere
  (Climate Change, El Niño, Ozone Hole, Greenhouse effect.)
- ✓ **SATELLITE info:**
  - related to OCEANS
  - related to the ATMOSPHERE
  - related to the EARTH
  - ATMOSPHERE-OCEANS-EARTH

OBJECTIVES AND APPLICATIONS

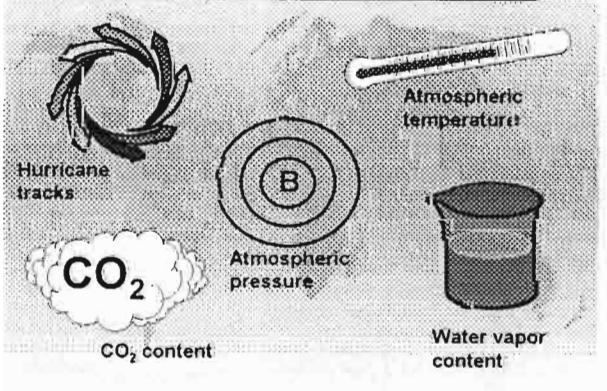
NATURAL HAZARDS REDUCTION	REMOTE SENSED DATA- Space-, Air-, Groundborne.
- KNOWLEDGE OF HAZARD BEHAVIOUR	◦ HAZARD ASSESSMENT
- KNOWLEDGE OF HAZARD PRONE AREAS	◦ RISK ASSESSMENT
- PREVENTION / MITIGATION	◦ HAZARD SIMULATION
- MAXIMUM POSSIBLE LOSS	◦ HAZARD FORECAST
- FORECASTING	◦ THEMATIC MAPPING
- DAMAGE ASSESMENT	◦ ENVIRONMENTAL MONITORING

REDUCTION OF: HUMAN LOSSES, MATERIAL DAMAGES AND COSTS

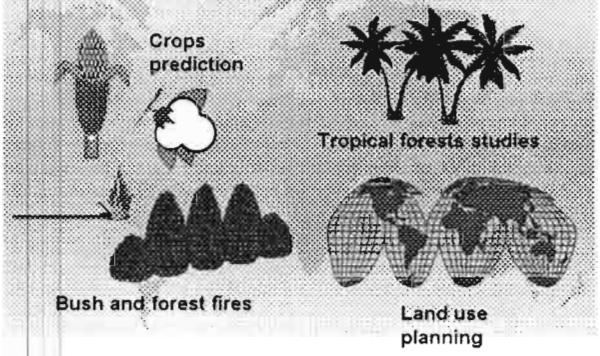
RELATED TO OCEANS



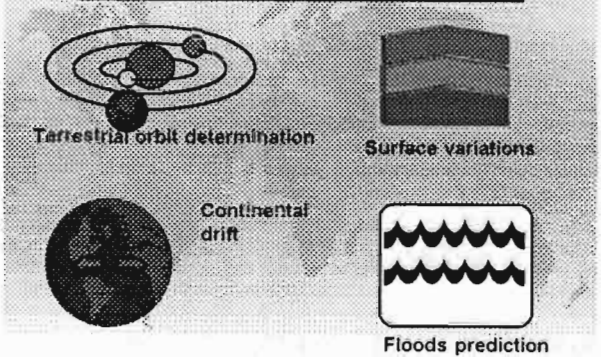
RELATED TO THE ATMOSPHERE



RELATED TO THE EARTH



RELATED TO THE EARTH



OCEAN-ATMOSPHERE-EARTH

- "El Niño" Southern Oscillation

(Pacific = weather kitchen of the Globe)

- Floods,windstorms, lightning on broadcasting and transmission lines.
- Flash-floods: erosion, collapse in tunes and ditches.
- Rain / windstorm: cancellation of outdoors events.
- Storm surges, high tides, coastal flooding, hurricane, erosion: port and habour installations.

OCEAN-ATMOSPHERE-EARTH

CLIMATE CHANGE. GREENHOUSE EFFECT.

- More tropical cyclones, windstorms, flooding, thunderstorms, hailstorms, tornadoes.
- Increased intensity and new scenarios.
- Growing demand for insurance cover.
- New insurance products uncorrectly rated.
  - Worrying predictions
  - Insuficient premiums
- Some governments: Pool of natural risks
- CONCLUSION: Suitable scientifical and technical basis is required.

GEOGRAPHIC INFORMATION SYSTEMS (G.I.S.)

- MARKETING STRATEGIES
  - Extension of new portfolios
  - New products
  - Assistance planning
- RATING PROCEDURES
- ALLOCATION OF RISKS (Accumulation Control)
- EVALUATING CATASTROPHE EXPOSURE

CONCLUSIONS

- ☑ Increasing insurance demand
- ☑ Improvement of standard of living
- ☑ Concentrations p/v in cities
- ☑ Rise in population
- ☑ Vulnerability of big cities
- ☑ Concentration of industrial business in hazard prone areas

WEATHER - INSURANCE

- Windstorms
- Floods
- Hail
- Lightning
- Droughts
- Ice-Drift
- Subsidence
- Snow
- Fog

- Agricultural
- Homeowners
- Industrial
- Marine
- Aviation
- Engineering
- Motor
- Credit
- Health
- Life

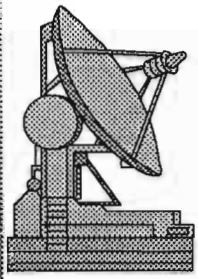
INSURERS-REINSURERS ROLE

- ✓ Lobbying for improvements in building codes.
- ✓ Promotion of safety.
- ✓ Financing technical and scientifical studies (A.F.R.A.I.D. for instance¡¡).
- ✓ Reinsurance companies committee on environment - development.

PRESENTATION A.F.R.A.I.D PROJECT

Rome, 27th june
L.U.I.S.S. University

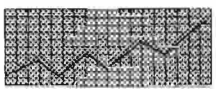
CONSORTIUM



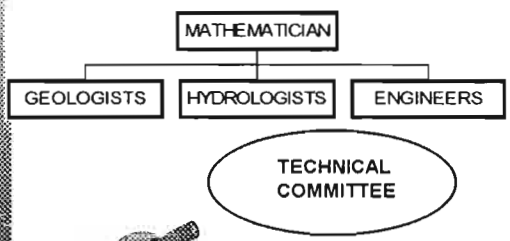
- Mapfre Re (Spain)
- C.I.A.R. (Italy)
- Cattolica (Italy)
- Ital Re (Italy)
- Nuova Telespazio (Italy)

A.F.R.A.I.D.

- A
- FLOOD
- RISK
- ANALYSIS
- for INSURANCE
- DAMAGES



NUOVA TELESPAZIO: Multidisciplinary team



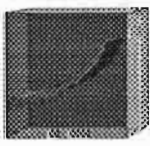
A.F.R.A.I.D. PROJECT

"PIXEL"

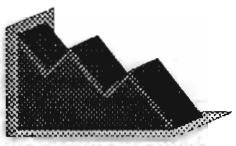
SUB-BASIN

ADMINISTRATIVE DIVISION

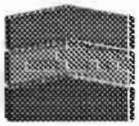
FACTORS



SLOPE



BASIN MORPHOLOGY



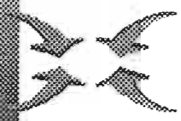
GEOLOGY

SOIL USES

FACTORS (cont.)

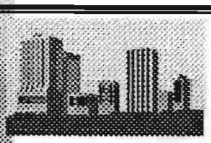
MAXIMUM PRECIPITATIONS

HISTORIC DATA



DISTANCE TO THE NEAREST RIVER

EXAMPLE: SOIL USES



urban areas

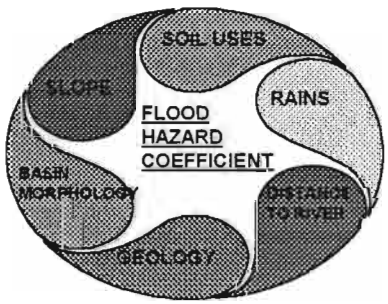
forests

INCREASING CAPACITY OF INFILTRATION

non vegetated areas

prairies

FLOOD HAZARD COEFFICIENT



A.F.R.A.I.D. PRESENTATION

- Your questions: next 27th June in Rome.