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ORGANIZATIONAL ADAPTATION TO CRISES: MECHANISMS OF COORDINATION AND STRUCTURAL CHANGE

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INTRODUCTION

Much of social life is so structured that behaviour occurs rather routinely. Most of the time, established and standardized procedures are followed, manifesting themselves in the habitual behaviour of individuals and/or the traditional actions of groups. At times however internal and/or external factors generate enough stress to make it possible to think of responding entities as being in a state of crisis. Crises require the reworking of established and standardized procedures or the creation of new means as well as of organizations for carrying them out. In a large part, the direction of response of groups and organizations is for certain aspects of emergent behaviour to be combined with elements of routinized organizational behavior.[1-3]

This paper seeks to extend the explanation of these types of adapation by using existing organizational theory. In particular it looks at the mechanisms whereby organizations are co-ordinated and shows how crises produce certain structural modifications which have implications for co-ordination. The intent is to provide sociological explanations for what is traditionally described as emergent phenomena. It argues that much of what has been called emergent can be explained by: (1) the heightened necessity for organizational co-ordination during crises; (2) the conditions which make for changes in the communication patterns within emergency organizations, and (3) the consequences the changes in communication patterns have for organizational co-ordination. These changes can be explained using standard organizational variables which are applicable to a wide range of types of organizations, not just organizations in emergencies. After establishing that theoretical orientation, we will come back to its application in crises.

THEORETICAL ORIENTATION

The theoretical orientation used here was derived from Hage *et al.* [7], in which organizational co-ordination is related to the internal structure of an organization. It argues that the predominant type of co-ordination in an organization is determined by its diversity and its internal distribution of power and status. While the theory was originally tested in a non-disaster context, the types of variables specified are particularly significant in changes which occur in the crises context.

One central concern in organizations is co-ordination. Co-ordination can be seen as the degree to which there are adequate linkages among organizational parts, i.e. among specific task performances as well as among sub-units of the organization, so that -- organizational objectives can be accomplished. [7] Organizations can be co-ordinated by plan and by feedback. The former is based on pre-established schedules and programmes directing and standardizing the functioning of organizations, while the latter is centred on the transmission of new information so as to facilitate the mutual adjustment of parts.

The two types of co-ordination are based on different assumptions about the nature of conformity to organizational objectives. In co-ordination by plan the activities of organizational members are seen as regulated externally by a system of rewards ensuring social control. If there is a clear blueprint for action, departures are obvious and sanctions can be applied with little ambiguity. In co-ordination by feedback errors detected in task performance are corrected by the provision of new information. Social control is seen as the result of internalized standards of professional excellence among the personnel brought about by occupational peer group pressures.

In summary, co-ordination by plan relies on external control over organizational members while co-ordination by feedback is more dependent on internal control.

Clearly, these two types of co-ordination are ideal constructs In reality, complex organizations use a mixture of the two It is possible, however, to identify organizational variables which would be associated with one or the other mechanisms of co-ordination Hage *et al.*[7] identify three: (a) uncertainty of tasks; (b) diversity, or the relative number of different occupations in an organization and their degree of professional specialization; and (c) the distribution of power and status within organizations. They argue that organizational co-ordination through feedback is more probable as the diversity of occupations and the variety and uncertainty of tasks increases. In the former case no one standard set of administrative guidelines and sanctions can regulate the activity of professionals appropriately and entirely. The latter puts a premium on the rapid exchange of information among organizational personnel. The growth of the volume of information and its directional diversification, with horizontal communication increasing as a result of these changes, renders co-ordination via planning improbable.

The probability of co-ordination via planning increases, however, with greater differences in power and status in organizations; the greater the hierarchical positional distance among personnel the less the extent of communication among them. External environmental factors such as homogeneity and stability are important determinants of internal structural variation. Previous studies would suggest [9,10,13,16] that stability of environment leads to routine technology and co-ordination by plan.

To summarize, the following propositions as suggested:

1. The greater the diversity of organizational structure, the greater the emphasis on co-ordination by feedback.

2. The greater the difference in status and power within an organization, the greater the emphasis on co-ordination through planning.

3. The greater the uncertainty of an organizational environment, the greater the emphasis on co-ordination by feedback.

RESEARCH ON ORGANIZATIONAL BEHAVIOR IN CRISES

The analysis of the activities of groups and organizations in crises have centered so far on the notion of emergence. Initially, this was a reaction against the prevailing views of social structure, which were too static to capture the behaviour which was observed in the field. Many organizational theories had as a focus some notion of bureaucratic structure where the organization was seen as an entity with clear cut boundaries, definite membership, formal roles, established lines of authority and specific tasks. This was too static a notion to describe organized behaviour in emergency.

Dynes and Quarantelli [2] derived a typology of group and organizational behaviour in crises from a cross classification of the (a) nature of the disaster tasks undertaken by groups and organizations and (b) their emergency period structure. They identified four types* of group behaviour

TASKS

		Regular	Non-regular
Structure	Old	Type I (Established)	Type III (Extending)
	New	Type II (Expanding)	Type IV (Emergent)

Fig. 1. Types of group behavior in disasters.

These two key variables point to differences in emergency operations when some group tasks may be old, routinely assigned, everyday ones or, on the other hand, the tasks may be new, novel, assumed or unusual ones. In addition, some groups and organizations operate in the emergency with an existing structure in which organizational members stand in definite kinds of pre-disaster relationships with one another in reference to work, as opposed to those who operate with a new crisis-developed structure.

The typology has been useful to account for the admixture of institutionalized and non-institutionalized behavior observed in emergency situations. It has been used to discuss the mobilization and recruitment of these groups and to identify types of problems such groups experience in task accomplishment, communication, authority and decision making (Reference 3, Ch. 7). In addition, the types have been used by Quarantelli and Brouilette (1971) as a basis for indicating what types of patterned variations occur in the adaption of bureaucratic structures to organizational stress. They suggest that complex bureacracies may exhibit all four patterns in a given situation. That is, some segments of it may operate as an established group while other segments may be involved as an emergent group with non-regular tasks. This is seen as a specific example of the debureacratization process

*Type I is an established group carrying out regular tasks. This is exemplified by a city police force directing traffic around the impact zone after a tornado has struck a community.

Type II is an expanding group with regular tasks, The group frequently exists on "paper," not as an ongoing organization prior to the disaster event, and would be illustrated by Red Cross volunteers running a shelter after a hurricane.

Type III is an extending group which undertakes non-regular tasks. This is illustrated by a construction company utilizing its men and equipment to dig through debris during rescue operations.

Type IV is an emergent group which becomes engaged in non-regular tasks. An example is an *ad hoc* group made up of the city engineer, county civil defense director, local representative of the state highway department and a Colonel from the Corps of Engineers who co-ordinate the overall community response during a flood.

Einsenstadt (Reference 4, pp. 302-320) and others have described.

While the typology has been useful as an explanatory device, it is necessary to provide other lines of explanation for adaptations to crisis either between or within groups and organizations. The typology depends much on the notion of emergence of new structures and tasks as a major factor in these adaptations. The identification of emergence, however, without providing for some sociological explanation, often leads to the conclusion that while the behavior of established organizations can be explained sociologically, emergent phenomena cannot. Emergent phenomena are often treated as atypical and asociological. We now turn to emergence adaptations within organizations. Others have analyzed emergence adaptations at the individual [8,17] and group levels. [5,6,11,14,15]

APPLICATION OF THE THEORETICAL ORIENTATION TO PREVIOUS CONCEPTUALIZATIONS OF EMERGENCE ADAPTATION IN ORGANIZATIONS

The theoretical orientation presented here has certain implications for organizational functioning in crisis. In general, crisis conditions cause organizational structure to move in the direction of co-ordination by feedback and away from co-ordination by plan. Moreover, crisis produces the conditions whereby the rate of communication increases as does the proportion of horizontal task communication.

Disaster creates extreme environmental uncertainty for organizations. The major variables used in the previous typology centre around new tasks and new structures. Either the acceptance by organizations of new tasks or of new personnel, or both, creates greater organizational diversity. Also, a number of observers of emergency situations [3] have commented on the status leveling effect of disaster. In effect, then, all of the conditions and consequences of functioning of organizations during the emergency period tend to move toward co-ordination by feedback and away from co-ordination by plan.

While usually described simply as emergent phenomena, organizational adaptation in crisis contexts seem to be accounted for by rather standard sociological variables. It is not by chance that Type IV in the typology is often illustrated by a group whose function is purely one of co-ordination. These factors also suggest the great difficulty of Type I (established organizations) in maintaining their pre-disaster co-ordination structure, since it is usually co-ordination by plan. Co-ordination by plan characterizes many of the traditional emergency organizations, such as police and fire departments. This schema explains why such organizations often "refuse" non-traditional tasks in disaster situations and usually have great difficulty in utilizing volunteers. In effect, their pre-disaster model of co-ordination would not "allow" such changes. Rather than increase their capabilities to meet the increased demands, such organizations tend to accept only those demands which are within their present capabilities. With continuity of regular structure and tasks, such organizations are able to keep their previous co-ordination patterns intact. On the other hand, rejected demands by some organizations have to be absorbed by others within the community, and they are more likely to be effectively handled by emergent groups or by those organizations which co-ordinate by feedback.

Established organizations experience organizational strain. When most of the organizations in emergency operations are moving toward co-ordination by feedback, established organizations are, in many ways, "out of step". There is a discontinuity in their attempt to maintain internal co-ordination by plan when the conditions relating to the emergency period are such as to move most other organizations further toward co-ordination by feedback. Such a discontinuity, in turn, creates significant problems in the e attempt of the community system to provide overall co-ordination.

In sum, then, the structural conditions of the emergency period make for uncertainty, diversity, decreased formalization and decentralization These changes increase communication. The non-routine nature of disaster tasks and the increased complexity of organizations require co-ordination by feedback. These shifts have been traditionally described as emergent but now they can be explained as being conditioned by those socioloigical factors which affect co-ordination.

IMPLICATIONS FOR POLICY

Research and conceptualization in organizational response to crises is one area which has rather direct policy implications. It is useful to make a note of an interesting paradox when the findings suggested here are compared with current policy with reference to emergency planning. In the United States, emergency planning is predominantly the responsibility of local government units. While it is somewhat diverse, there is great consistency in the direction taken by emergency planning. Most is orientated toward increasing the centralization of authority and the formulization of procedures. In other words, co-ordination by plan is considered to be normative. This mode of co-ordination is seen as most appropriate, since a military model of organizational functioning in crises is assumed to be most effective in such circumstances. In addition, planning is directed toward the development of social control mechanisms, i.e. rewards and punishments, to implement this mode of co-ordination. These assumptions of emergency planning are seldom questioned, since many individuals engaged in such planning are recruited on the basis of their previous military experience or come from municipal agencies, which operate routinely by co-ordination by plan.

On the basis of what has been described here, the dominance of a normative planning model which emphasises co-ordination by plan is, at best, questionable. The crisis event itself creates the conditions where co-ordination by plan is inappropriate. This inappropriateness, however, is not likely to be challenged in post-disaster critiques of organizational functioning, because the norms used to judge organizational effectiveness are such as to lead to negative evaluations of organizations which utilize co-ordination by feedback. The tremendous increase in communication is taken as a failure of co-ordination, not as a condition necessary for it. While this is currently a widespread paradox, it does not have to be perpetuated. Emergency planning can also be directed toward improving and facilitating co-ordination by feedback, since it is likely to be the dominant mode in emergency conditions.

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PLANNING PROCESSES IN DISASTER PRONE AREAS WITH REFERENCE TO FLOODS IN TUNISIA

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INTRODUCTION

This report is concerned with "How to build after disaster has occurred?". This paper is an attempt to answer the question on "where to build?" or what planning processes need to be considered in advance before developing a disaster prone area or in reconstruction after disaster has struck. Methodology for risk analyses is an essential issue for development of any area with disaster probabilities. A reference to flood disaster in Tunisia is made.

BACKGROUND

Natural disasters account for a substantial loss of both life and property throughout the world. Developing countries are particularly vulnerable. In these countries losses due to natural disasters are often of the same magnitude or even exceeed the annual increase in GNP, thus negating development or even resulting in negative growth. Although substantial resources are currently submitted annually to disaster relief, the efficiency of this aid has often been unsatisfactory. This is due primarily to two reasons:

1. The failure of aid-giving organizations to relate disaster aid to general development effort and a tendency to look upon disaster relief as isolated charity not related to general development goals.

2. A general lack of planning which has led to an emphasis on post-disaster curative activities instead of on pre-disaster preventive measures.

The improved communication facilities of today have increased the awareness in the developed world of the damage caused by natural disasters in the developing countries. As a result of this, large sums of money are given for disaster relief purposes by the developed countries. If, however, the intention of the donor countries is not merely to alleviate their own consciences due attention must be paid to how the money is used by the recipients. An intelligent application of the resources made available must be based on a sufficient amount of planning in the pre-disaster phase. At present, resources utilized for such purposes in the world to day, are infinitesimal.

Adjustments to natural hazards

Adjustments concerning natural hazards involve two main distinct approaches: a technological approach and a social or behavioural approach. The former emphasizes control of nature itself and has received greater encouragement by authorities and the general public. The latter approach emphasizes mitigation measures directed towards the physical structure. This is based on a full understanding of the disaster risk. This approach has received less attention, or has even been neglected.

Vulnerability analysis would be necessary to identify various risk levels and potential damage, and assess the acceptable level of risk to life and property and to improve existing protection facilities, warning systems and emergency plans. The growth of development should be encouraged in non-hazard or well-protected zones. Economic and social growth should be restricted, density of population, types of activities and areas of settlements should be controlled in disaster prone areas.

Natural hazards adjustments and flood plains

There is a relationship between these two approaches and flood loss in various regions of the world.

Developed countries emphasize technological adjustments involving control of nature itself and engineering construction work that requires professional staff and high capital expenditure. In these countries, urbanization has spread extensively into hazard zones and therefore the average damage loss per event is extremely high.

In flood plains of the developed countries, protection systems for the control of flooding in different areas already exist and are being further developed. Nevertheless some of these countries still need to establish land-use legislation and building regulations, particularly, in high risk areas.

In developing countries, where there are little or no disaster protection measures, choice of adjustments should be based on local demands, needs, priorities and an economic evaluation in relation to the character of the disaster, frequency of occurrence, magnitude and potential damage pattern. Sophisticated technical solutions from high-capital societies in industrialized countries cannot be directly transferred to low capital societies which are non-industrialized and have a restricted economy. Social adjustments seem to be the most relevant approach and a logical point to begin with.

In examining these adjustments, two categories of populated regions should be distinguished. the first, where there are existing densely populated settlements and human activities located largely in hazard zones where potential damage is high. The second, where there are less densely populated settlements, but due to random expansion might extend to disaster-affected areas, that have not been previously developed or settled.

With reference to flood-prone areas, the first category is typified by areas where there is extensive growth of population and agriculture settlements located on flood plains, often, with little or no flood protection measures, or water management programmes as well as the probability of a lack of adequate data in hydrology and maps. The second category is typified by areas where development has just begun to take place in flood plains. In the second category, the real urgent need is not to start with heavy investment input in flood control measures involving engineering construction work and staff training. What is needed is a simple and effective approach linked with the roles of the individual and society. Social adaptation would involve attempts to minimize potential damage within existing facilities. This would be based on disaster vulnerability analyses that would provide a clear understanding of the disaster risks and the identification of each hazard zone in correspondence with the vulnerability of different social activities. Definition and demarkation of hazard zones has to be presented to government personnel and the general public in a form they can comprehend.

A second stage would entail a situation where people would be prepared to meet a disaster or "Disaster Preparedness". A realistic pre-disaster plan would be necessary to minimize the effects of disaster to life and property.

Through the existence of previous risk analyses, relief efforts could be specified more precisely and put in priority. Vulnerability mapping serves to guide the growth of development by keeping hazard areas free from development and avoiding economic and social dislocation by restricting development to non-hazard areas.

Land-use legislation should set up special criteria for land-use patterns in each hazard zone and establish guidelines for future development. Regulations should be drawn up to determine acceptable densities of population, use of land, types of settlements and activities.

Building codes should consider potential losses to structures and function of building during and after disaster in each hazard zone. They should encourage development of local building techniques and materials and techniques of flood-proofing structures. Evaluation of hazards to new constructions and existing buildings would help to develop standards and new techniques for construction in flood affected areas

It would be reasonable to recommend for disaster prone areas, that a comprehensive programme of disaster risk analyses and mapping for all potentially affected regions should be undertaken. Long-term adjustments should be most strongly recommended and should be included in land use planning and building design. A later and heavier capital input would be used to set up hydrological stations to utilize the available data for flood forecasting and flood warning, followed by more costly measures directed towards modifying nature.

State of art

Natural hazards have not been totally recognized in land-use planning, design of structures, construction and materials in buildings. Land-use planning could be effectively used to reduce the hazard of natural disaster. This can be accomplished by mapping these areas and evaluating the degree of risk to determine whether these areas should be developed or not. Attempts should also be made, where feasible, to discourage high concentrations of people or public facilities in high risk areas.

Current land-use legislation and building regulations do not take account of disaster risks, and are not therefore intended to minimize damage to buildings in the event of a disaster, or to maintain the function of buildings after a disaster has occurred. The continuation of building functions during and after a disaster is highly desirable since it would tend to support emergency activities and facilitate the return to normal economic and social function within the shortest period of time following a disaster. In general, disaster risk is neither contemplated nor considered by either the general public or authorities in many of the disaster-prone countries, both developed and developing.

Architects are seldom able to consider potential damage in the design of buildings or establish methods for reducing risk possibilities. In the case of Tunisia, for example, most of the rural houses are of baked-mud construction The base of such houses, once wet, crumbles, causing the house to finally collapse. In urban areas, damage to houses is due mainly to the ignorance of certain basic construction techniques. Buildings have been constructed on the basis of minimum engineering input, and often the design of dwellings has depended on the experience of contractors who do not generally take account of potential disaster damage. Building sites are often located in low plains subject to flooding and materials used are not flood damage resistant.

GAFSA PROJECT

The purpose of this study is to examine work methodology for flood risk analyses, to evaluate flood hazard and to deal with practices for land-use planning, physical legislation and building codes in flood-prone areas. The goal is to identify various risk zones based on calculation of x-year floods. The x-year flood has a magnitude which occurs once every x-year, on average. This is a statistical definition and, for example, a 100-year flood may occur more than once within any 100-year period.

Definition

A risk zone map in a flood-prone area is a means of presenting flood-zones of various risk levels including associated risks such as erosion, sedimentation etc.

General description of the studied area

The catchment area of Oued Bayech is one of the largest in the south-central part of Tunisia. It comprises 5520 km^2 upstream from Gafsa town. A great part of the area is situated on Algerian territory and is drained by two larger rivers, Oued Sidi Aich and Oued El Kebir. The former drains an area of 2330 km^2 and the latter an area of 3190 km^2. The two rivers join just north of Gafsa and the resultant river is called Oued Bayech.

Gafsa, which is the seat of the provincial government, has a population of about 50,000 in a region which for the rest is sparsely populated. Sheep-farming, sometimes combined with other farming forms the main occupation in the countryside. South and southeast of the town is situated the Tunisian phosphate-mining district.

A large part of the area consists of a high plateau. Mountain massifs rise up from the plateau on the fringes of the area. Due to the high erosion tendency of the predominant kind of rock, ravines are very common. To the north, the area borders on the highest mountains in this part of the world, the Tebessa-mountains. Vegetation is, except in the oasis very sparse: to the north, dry hardy grasses and bushes are common and alfalfa is also found. On the Algerian border there are small pine woods in the mountains.

The bedrock in the southern and eastern part consists of sanstones, limestones, dolomites and rocks rich in gypsum. In the northwest there are quaternary formations alternating with porous and clayey limestones. The very easily weathered rocks in the area affect the runoff-pattern and cause a large movement of sediments. The soils consists mainly of brown soil types. East of Gafsa there is an area with limy sandy clay or silt. In the river beds there are alluvial sediments which are transported and restratified during heavy floods and the different layers can easily be seen. When the velocity of the water has been high, gravel and small blocks are deposited, and when it has been low, silt and clay are deposited.

Climatology and hydrology

The catchment area is situated on the border between the arid and semi-arid climatical zones. The yearly amplitude of Gafsa is approximately 20°C.

The yearly average precipitation for Gafsa is 155 mm and 228 mm for Feriana (which also is situated in the same area). Taking the area as a whole, the annual rainfall lies between 150 - 400 mm. This can be compared to the potential evapotranspiration which is calculated to be 1,200 mm per year. The climate can be summed up as continental semi-arid.

The cyclonic activity in North Africa reaches its maximum during winter. This occurrs in connection with the Polar Front which spreads out over the Mediterranean during winter The precipitation which falls on the cyclones' cold fronts is often intensive and can cause extensive damage through floods.

Because of the nature of the ground, which is silty earth often with a hard surface, the scanty vegetation and the force of the rain, a dense network of runnels have developed. This means that the water is rapidly conveyed to the main water channels. From the most distant point in the catchment area to Gafsa, the run-off time is approximately 12 hours. There are no lakes which means that the only form of storage which takes places is in the soils and in the ground.

On 12 December 1973, a heavy flow was measured in the following three places with the following results

Sidi Aich 710 m^3/s
Sidi Bou Baker 1000 m^3/s
Gafsa 1330m^3/s

The greatest risk for floods in Gafsa occurs when the maximum discharge from the two sub-regions join together. In order that this should occur, the rain maximums in the two sub-regions must be delayed. There are five run-off measurement stations in the catchment area, one with direct radio contact to the newly established organisation for flood warning. The two oldest, those in Oued Sidi Aich, were installed round about 1960 whilst the three others are between three and six years old.

Method of flood – risk analysis

The method which has been used for risk-zone mapping in Gafsa can be divided into two parts. On one hand, there is a calculation of the characteristic flow patterns and on the other, a calculation of the corresponding river cross-section. Using this as a base together with a detailed survey of the area, it is possible to determine zones with different flood risks.[3]

In order to calculate characteristic flows, there are several methods whose suitability for use is dependent on the type and amount of basic data which are available.

1. If a long series (at least 30-50 years) of continuous run-off measurements are available, it is possible to demonstrate by simple statistical analysis a connection between the size of a flow and the probability of occurrence. The analysis is usually based on annual maximums and if the probability for a certain flow is 0.1 (1/10), that means that the flow occurrs on average once every ten years. One says that the frequency or recurrence interval is 10 years.

2 If simultaneous observations of precipitation and run-off are available shorter run-off series can be extended with the help of longer precipitation series since the connection between precipitation and run-off is calculated

3. If only precipitation data is available, the run-off can be calculated according to the so called rational method for small areas.

Q = $A K i$
A = catchment area
k = run-off coefficient
i = intensity of rain.

When dealing with larger regions, this method is combined with retardation calculations. With the help of information on the soil-type, the slope of the ground surface etc, the speed of run-off can be calculated for the ground-surface as well as the channel. One calculates the time it takes for the water to run from different points in the catchment area to a certain point in the water channel. Places which have the same flow-time are connected by isochrones. The intervals between the isochrones are selected with reference to the size of the area and the accuracy which is demanded. The region between two isochrones is calculated. The run-off coefficient for the region is calculated and the product of these two components gives the reduced area for the region.

With the help of the reduced area and the time-distance ratio for the regions a time-area graph can be constructed, one for each interesting rainfall. Every sub-region doesn't contribute immediately to the total run-off from the area, but also, the run-off doesn't stop immediately when it ceases to rain. The time-area graph's appearance is influenced by the area's composition, slope-conditions, amount of rain etc. All the individual time-area graphs can be drawn together and this makes it possible to show the time-area diagram for the whole area.

The summation of these curves have the same shape as the hydrograph. Closer isochrones result in a more even graph shape. By multiplying the ordinates in the time-area graph with the figures for rain-intensity the hydrograph can be constructed. The rain intensity is dependent on the duration of rainfall. The time-area curve is drawn up for different durations. The maximum value in every time-area graph is multiplied with the respective rain-intensity figures. These products are then compared in order to select the duration which gives the greatest flow.

In the next step, the intensity of the rain is calculated when the duration is at the optimum. For this purpose, different formulas are applied based on empirical research.

Does then a calculated 100 years rain give a 100 years flood? For a small catchment area with limited storage capacity, the correlation ought to be good. For a large area, the probability of a surface-covering rainfall is smaller and the correlation between rain and flow is difficult to distinguish if the precipitation observations are few. The hydrographs from different sub-regions in a large area can be delayed in relation to the normal case, depending on how the rain pattern is moving.

For Gafsa, the latter described method has been suitable for calculating the time-area diagrams, precipitation intensity and the flow. The area which has been mapped as a risk-zone is a slightly over two km long belt alone Oued Bayech. The area has been surveyed in detail (land-surveys, ground maps, aerial photos) and the flooded area has been calculated.

Difficulties appear when judging whether a certain district shall be labelled as a transit area for the water or as a temporary storage area. A comparison between the calculated flood-prone area and the documentary evidence from a couple of floods shows convincing conformities.

Applications of the risk map

The risk zone map can be further developed for several other uses, for example.

1. Map for insurance that indicates different insurance rates for buildings in disaster prone areas based on the magnitude of the disaster.

2. Future development map that identifies all safety zones which can be available for further development.

3. Emergency relief map which shows how the evacuation from dangerous zones can be carried out effectively and safety areas for evacuation or even for refugee camps or rehabiliation.

4. Permanent/temporary preventive measures which specify all types of preventive measures for long-term that can be taken, also other temporary measures/actions when disaster strikes.

NEW PROJECTS

The conclusions from the Gafsa project were recounted at a Tunisien-Swedish seminar on the problems of floods which took place in Tunis in May 1976. This seminar was organized by the Institute Agronomique Nationale in cooperation with, amongst others, the Swedish Aid department in Tunis and the Royal Institute of Technology in Stockholm. The seminar stressed the necessity to determine the flood-risk zones as far as the extension and risk levels were concerned, in order to give a satisfactory planning base for the development and protection of urban as well as rural areas.

A programme for continued co-operation has been worked out and consists of three parts.

1. Completing the Gafsa investigation with the aim to produce a town plan.

2. Working out the risk-zone map for the towns of Tebourba and Djedeida with their surroundings and using that for a proposal for the land-use plan.

3. The compilation of a risk-zone map for the whole of Tunisia.

The realisation of the programme's first and second parts has begun as a joint-project between the Royal Institute of Technology in Stockholm and several different authorities in Tunisia.

Of basic importance for risk-zone mapping in and around the towns of Djedeida and Tebourba are data relating to the actual drainage system (Medjerdahs catchment area). The parameters which are meaningful are naturally, water discharge, water levels and information on the flooded areas. Besides hydrological data, geological, geomorphological and geotechnical data are also required.

Intensive precipitation and associated heavy flows and floods occur often. Floods with more serious consequences have occurred on ten separate occasions during the 20th century (1907, 1931(2), 1940, 1947, 1948, 1952, 1959, 1969, 1973). Information on the exact moments in time, water discharge at various measuring stations etc. has been collected. The flood in 1973 was extremely powerful and there is plenty of well-documented information relating to it in terms of statistical information, maps, photographs etc. The size of the area which was flooded in 1973 has been calculated to be approximately 650 km^2 Amongst other areas, large areas around the towns, of Djedeida and Tebourba were flooded. The floods don't only mean that it is a problem of land being submerged leading to damage to crops, agricultural land, roads, other technical systems, houses and so on, but also means a great deal of silt being deposited which is a serious problem. Information is available which shows that in certain areas it has taken several years to restore agricultural land, in other words remove the deposited silt

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