MOROCCO

PROTECTION OF WATER CATCHMENTS AGAINST CONTAMINATION AND EMERGENCY PROCEDURES IN CASE OF TOXIC POLLUTION OF WATER RESOURCES

H. Abou Zaid

1. INTRODUCTION

The major water resources around the globe have, in recent years, been subject to serious instances of accidental pollution with negative impact on the environment and this has led to an increase in public awareness. Amongst the serious cases have been that concerning the town of Anvers where the treatment plant supplied by the Albert Canal water has been shut down 170 times in 10 years (1972-1982), because of accidental pollution events [1], which means it has been closed a total of 2123 hours or three months. In Japan, the statistics concerning cases of accidental pollution which have led to the turning off of water treatment units amount to 183 in 1967 and 85 in 1980 [1]. In Morocco, one pollution incident has led to the turning off of a drinking water treatment station for three days [2].

The causes of such pollution are generally categorized as follows:

Endogenous causes: accidents due to the age of the installation, construction defects, maintenance negligence or unreliability of power supply, etc.;

Exogenous, natural causes: exceptionally low water level, hurricanes, atmospheric disturbances, exceptionally hard frost, earthquakes, landslides, soil corrosivity etc.;

Exogenous, man-made causes: discharge of polluting substances upstream of the water catchments, works in the vicinity of hydraulic installations, accidental fall of loads being conveyed, mishandling, terrorism, war, etc.

These causes are routinely a matter of concern to the people in charge of the production of drinking water and who have to protect the sources. The task of securing drinking water distribution remains a daily challenge for the water supply professionals who have to ensure continuously potable water in sufficient quantities for all customers.

Whether the water is pumped out of a waterway or water table does not affect significantly the attitude to be adopted in a case of accidental pollution. The priorities, that is, giving the alert, identifying the nature of the danger and triggering any necessary measures to circumscribe it or at least to control its impact on the production of drinking water remain the same, because only an efficient intervention in the first hours following the accident can eventually reduce the consequences.

The National Drinking Water Supply Agency (ONEP) acting as the planner, producer and/or distributor of drinking water in Morocco, has endeavoured to set up organizational and technical procedures that would enable protection of the water catchments used for drinking purposes, and to make provisions for alternative drinking water supplies in the case of pollution of a major water resource, in the form of an emergency action plan.

2. PROTECTION OF WATER RESOURCES USED FOR DRINKING WATER PRODUCTION

The first step in the protection of resources of water for drinking purposes is usually the identification of protection zones more or less extended around the water catchment. Although the underground and surface water resources are both strongly interdependent, the approach in terms of identifying the protection zones is different, according to the specific characteristics of water circulation in the underground tables.

(a) Protection zones around the underground water catchments

Specific protection zones which are subject to particular activity limitations are generally identified around the resources used for drinking water in order to prevent bacterial pollution and, in some cases, chemical pollution.

(b) Protection zones for surface water catchments

The protection zones of the natural or man-made lakes used for potable water production concern mostly those lakes or reservoirs where the water is taken directly from the lakes and when these lakes are reserved solely for drinking water production.

For works of small size, it is quite common for the protection zone to include not only the lake itself and its immediate surroundings but also its draining basin as is the case, for example, in Great Britain and Norway. For larger lakes, however, the protection zone is sometimes restricted to a portion of the water surface and its surroundings.

A special aspect concerning protection zones of the reservoirs used for the production of potable water pertains to the increasing pressure for the use of these water surfaces for leisure purposes. This pressure increases with the size of the water surfaces and the ease of access.

3. EMERGENCY PROCEDURES IN CASE OF WATER POISONING

Even when water resources protection zones are effectively set up and the necessary measures to combat pollution are implemented, the water production remains vulnerable to incidents which could pollute the resources and degrade the quality of the water. Examples and instances of water resource pollution by hydrocarbons and pesticides identified in Morocco by the ONEP are tabled in Appendixes I and II respectively. Most of these incidents disrupted water supply to the populations concerned.

The question that addresses the water supplier facing an instance of water poisoning can be formulated as follows: What is to be done in the case of an unexpected case of severe pollution affecting a resource in use for the production of potable water, in order to maintain, as far as possible, the water supply to meet the needs of the population and, at the same time, prevent the pollution from affecting the population's health? To further develop the question, one can also add: What can be done to prevent this kind of accident from occurring repeatedly?

The importance given by ONEP to this issue led to the holding of a workshop seminar on emergency situations in terms of drinking water supply. This workshop seminar took place in October 1989 [2] and aimed:

- to sensitize a maximum number of technicians and decision makers in the sector to the issue;

- to work out two first-draft action plans for two typical instances of water resource pollution in Morocco: hydrocarbon contamination and pesticide contamination.

The outlines of the action plans are contained in Appendixes III and IV respectively for the hydrocarbons and the pesticides.

Moreover, the ONEP is currently involved, in collaboration with the United Nations Development Programme, in a study of the component "Drinking water supply in case of toxic pollution" within the framework of the project pertaining to water saving strategies and the improvement of equipment (MOR/87/005). The broad lines of this action plan are as follows:

- A historical study and analysis of the cases of accidental pollution identified at the level of the reservoir, lakes or underground water tables, both in Morocco and other countries;

- Drawing up of an inventory of the principal potential sources of massive pollution, the water resources most exposed to such polluters, and the suggestions for remedy;

- A study of the feasibility and setting up of means of surveillance of the major incidents of accidental toxic pollutions, as well as of warning systems;

- Researching into the possibilities of increasing the capacity of existing treatment installations and of mobilizing alternative resources in case of serious pollution of the vulnerable resources;

- Drawing up of an emergency plan for providing a minimum water supply to the population from alternative water resources when use is to be interrupted;

- A study of the criteria and the methodology to be applied in order to adapt the emergency action plan to a case of earthquake and/or accident at the level of a key installation.

REFERENCES

[1] Kuspert P.L., *et al.* Protection des Eaux Superficielles Contre la Pollution. General report No.1 IAWD, 1984 Conference.

[2] Abou Zaid, H. Incidents de la Pollution par les Pesticides Enregistrés à l'Office National de l'Eau Potable. Workshop Seminar on emergency situations in terms of drinking water supply, Rabat, 25-27 October 1989.

APPENDIX 1

CASES OF HYDROCARBON POLLUTION IDENTIFIED BY THE AGENCY

1. THE PROBLEM

The issue of accidental pollution of water represents the scenario most feared by drinking water producers and distributors. It is caused by the instantaneous contamination of the waters by chemical or biological agents. Of the chemical agents, the hydrocarbons generate the severest environmental impact translating into damage to the fauna and flora of the aquatic milieu and leading also to the deterioration of the organoleptic quality of the water for consumption purposes. The number of cases of hydrocarbons spills has been increasing steadily in recent years. The National Drinking Water Supply Agency has had to deal with eight incidents since 1985:

- five occurring upstream of drinking water catchments;
- one at the level of a drinking water production unit;
- two the level of the drinking water distribution network.

2. CASES OCCURRING UPSTREAM OF THE DRINKING WATER CATCHMENTS

Of the five cases occurring upstream of the water catchment, four led to the immediate shut-down of drinking water production from the polluted catchments.

2.1. Underground water resource contamination

One case, that of the Berkane area (rural commune of Madagh) which occurred on May 11, 1988, was due to a faulty petrol station container, and resulted in infiltration of hydrocarbons into the underground water resource.

2.2 Surface water resource contamination

Four incidents contaminated surface water resources.

(a) Hydrocarbons were spilt into the reservoir of the Abdelmoumen Dam on two occasions, in November 1985 and in March 1989 following the accidental overturning of trucks carrying hydrocarbons. The principal means employed to deal with the pollution by the Hydraulic Department were wood sawdust for the first instance and fire for the second.

(b) In October 1988, hydrocarburates were spilt when a lorry overturned on a bridge of the national roadway (RP1) over the Beht River in Khemisset region, leading to the pollution of the whole of the river basin all the way to the intake point of El Kansera Dam water reservoir. The water treatment station of the reservoir, which supplies the towns of Tiflet and Khemisset, was not shut down thanks to the size and effectiveness of the depollution operation. This operation, which was conducted by the Hydraulics Department, the local authorities and civil defence staff, used packed hay which prevented the spill from expanding over the whole surface of the water.

(c) In a similar accident, a truck carrying hydrocarbons overturned in February 1987 on the bridge of RP1 over the Sebou river, resulting in the spilling of hydrocarbons into a portion of the Sebou river, upstream of the

crude water catchment connected to the drinking water treatment station for the supply of the town of Fes. This station was shut down following the identification of hydrocarbons emulsion on the water surface.

3. CASES OCCURRING AT THE LEVEL OF DRINKING WATER CONVEYING UNIT

The only case identified to date pertains to an accident involving a truck which occurred in October 1988 in the vicinity of a drinking water mains, connecting the Boujniba reservoir to the Water Distribution Agency (RAD) reservoir in Khouribga. Twenty-one tonnes of hydrocarburates were spilled along the water mains to such an extent that the infiltration into the soil reached the body of an inspection point of the mains. Excavation was required to shield the threatened mains.

4. CASES OCCURRING AT THE LEVEL OF DRINKING WATER DISTRIBUTION

In April 1987 ONED assisted the Water Distribution Agency following contamination of a section of the drinking water distribution network in Oujda by hydrocarbons. This contamination was caused by reverse flow from a siphon starting from a container in which a hose was immersed and hooked to a water tap of a garage for vehicle repairs.

The other incident occurred in Berkane in July 1989, when a water mains was contaminated by hydrocarbons originating from a petrol station.

In both cases, the depollution involved replacement of the contaminated sections of the network.

5. CONCLUSIONS

It is obvious following this brief inventory of the accidental pollution of water by hydrocarbons that the majority (62%) of these incidents result from road accidents. Therefore, action should be taken to combat this kind of pollution at the level of hydrocarbons transportation. Moreover, any action plan should also aim:

- to make an inventory of and to categorize the hydrocarbons on the national market;
- to draw up a vulnerability map of the water resources;
- to develop detection methods for all these polluting agents.

APPENDIX 2

CASES OF PESTICIDE POLLUTION IDENTIFIED BY THE NATIONAL DRINKING WATER SUPPLY AGENCY

Within the framework of its activities pertaining to control of pollution to waters liable to be used for drinking, ONEP has had to deal with three instances of accidental pesticide contamination of the water.

1. THE LOUKKOUS CANAL CASE

Contamination of the Loukkous Canal waters by pesticides occurred on two occasions in June and November 1983 and caused massive mortality among the

fish population. The analyses carried out by the toxicology department of the Hassan II National Institute for Agronomy and Veterinary Science on both water samples and fish revealed high concentrations of organochlorinates.

It should be noted that at that time, the central laboratory of the ONEP had not yet been equipped for identification of pesticides and so the Loukkous Agricultural Development Agency was requested by the regional office to take part in the inquiry into the incident.

2. THE MOHAMED B.A. AL KHATTABI DAM RESERVOIR CASE

An accident spill of pesticides into the reservoir of the dam supplying drinking water to the town of Al Hoceima and neighbouring population centres was suspected in October 1987, following heavy flooding in the drainage basin which washed away a drugstore which sold pesticides.

Among the actions taken to counter the incident; ONEP

- shut down the water treatment station for three days;
- used activated coal for two months;
- tapped underground resources for the supply of drinking water.

3. IMPACT OF THE ANTI-LOCUST CAMPAIGN ON DRINKING WATER

Within the framework of the study on the effects on water resources used for drinking water purposes of insecticides used in the fight against locusts, carried out in Morocco between October 1987 and July 1988, ONEP organized pesticide control campaigns in the waters of the regions invaded by locusts.

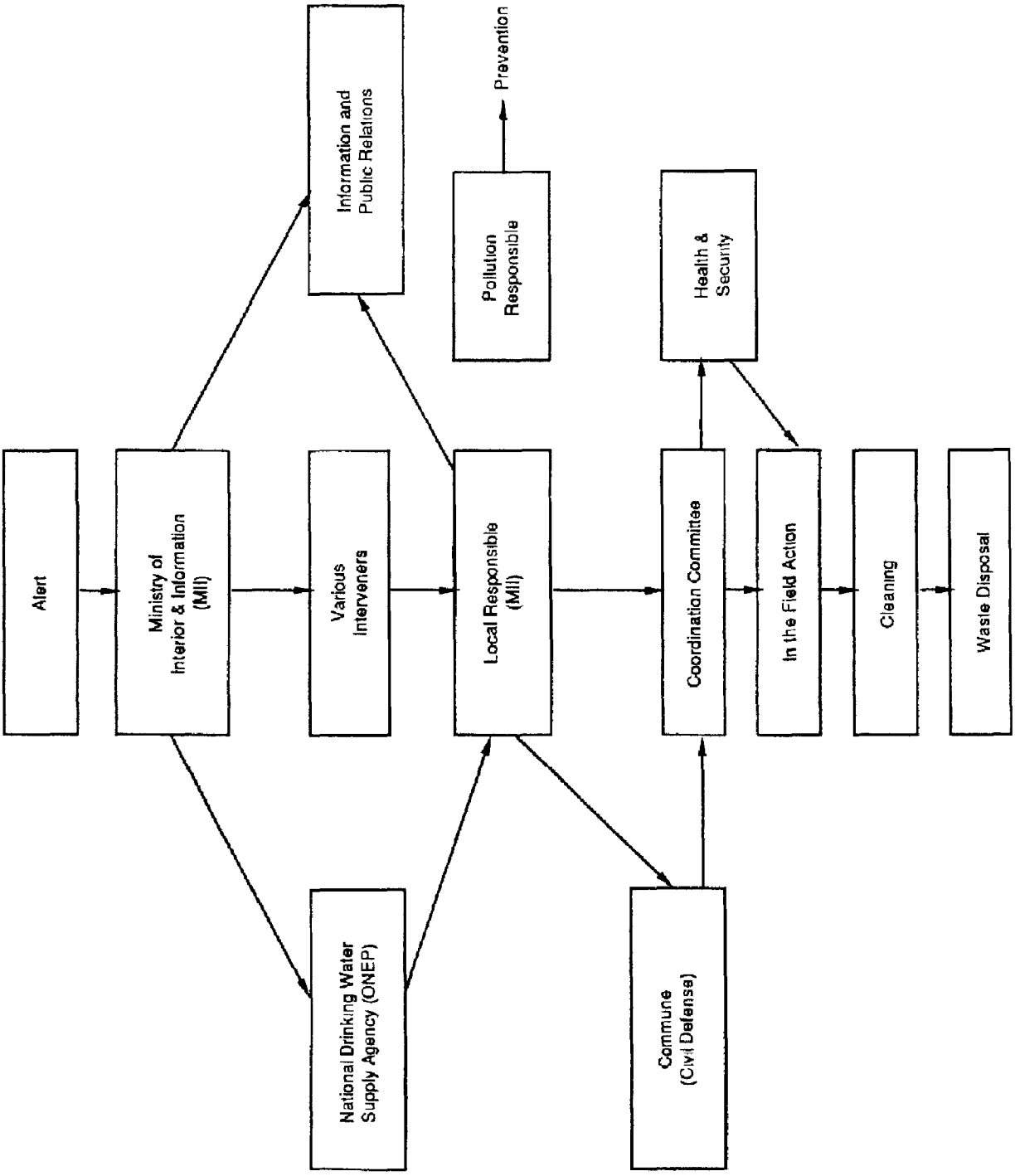
In a note issued by ONEP and distributed to the national authorities involved in the anti-locust fight it was concluded that:

- With regard to the resources used by ONEP for the production of drinking water, pesticide valdes were not detectable through the analytical methods used. Their concentration therefore was lower than the reference norm advocated by the World Health Organization.

- With regard to the two centres of Boudnib and Figuig, values for the two pesticides malathion and fenitrothion were detectable but remained clearly lower than the maximal values recommended for drinking water.

APPENDIX 3

ACTION PLAN IN CASE OF WATER POLLUTION BY HYDROCARBONS



OUTLINE OF ACTION PLAN IN CASE OF HYDROCARBURATE POLLUTION

PREVENTIVE ACTION

- Legislative and Administrative Aspect

STANDARD PLAN IN CASE OF WATER SUPPLY EMERGENCY

1. Emergency planning

   - Communication network
   - Basic intervention plan (organogram)

2. Intervention after spill

   - retention of hydrocarburates
   - recuperation

3. Cleaning up

4. Equipment

- Assessment of damage

- Legal follow-up

APPENDIX 4

OUTLINE OF ACTION PLAN IN CASE OF PESTICIDE POLLUTION

A PREVENTIVE ASPECT

1. Information

To sensitize the population through information circulation:
- Posters;
- Schools;
- State administration offices;
- At the users level.

Who to inform?
- Structured distribution: Producer and/or distribution;
- The administrative authorities: in a place where information concerning water is catalogued;
- The consultable experts;
- The particular distributors (wells).

How?
To be defined according to region.

2. Resources

- Protection perimeter;
- Inventory of waste;
- Inventory of potential pollution sites;

Surface water
- Vulnerability;
- Transit period;
- Dilution rate;
- Provisions of stocks (crude water, treated water).

Underground water
- Vulnerability;
- Transit period;
- Water reserve;
- Origin;
- Complete catchment file.

3. Polluter

Responsible for the wastes: inform the producer, the importer, the distributor, the user or the transporter. The transporter must have an identification file of the product he conveys showing:

- characteristics;
- instructions for use;
- treatment instructions in case of accident.

Information about the risks

- of spreading
- when filling up;
- when cleaning up;
- controls;
- sanctions.

4. Polluting agent

Knowledge at the level of homologation, formula.

Behaviour:
- In natural surroundings;
- In the treatment chain.

Quality of product:
- Imported;
- Produced;
- Transported.

Polluting agent file, containing the following data:
- Molecular weight;
- Developed formula;
- Solubility;
- Polarity;
- pKa;
- Boiling temperature;

- Biodegradation;
- Toxicity;
- Hydrolysis means;
- Treatment means:
    - on the spot;
    - in the river;
    - at the treatment station.

Utilization: Dose per acre, for example.

5. Treatment station

- Description of the unit with update of the daily work;
- Stocks profile;
- Crude water and treated water resources.

6. Network

Supply and distribution network plan:
- Reservoir: reserves profile;
- Protection: water return or introduction.

State of the premises;

Wastewater:
- Containers and pressurized systems;
- Protection perimeter;
- Anti-intrusion protection.

For other sensitive consumers: hospitals who should have their own reserve (about one day).

B. CURATIVE ASPECT

1. Information

Information should reach a place - one place - giving the precise date, the hour and the location of the accident.

- Obligation of information;

- Define the location or the information receiving end. The water distributer has priority;

- Effects noted on the spot

- Accident: precise pollutant:
  - name;
  - quantity;
  - type of protection;

  - Identification of the informer.

2. Environment

Existing protection or to be set up

The soil:
- control depolluting agent with coal, sand, soil, hay, manure, etc.;
- obstruct all openings (sewage, etc.);
- protect staff.

The water:
(a) If the density of the polluting agent is lower than 1 it can float up and be dealt with in the same manner as the hydrocarbons (hay barriers, sawdust, shrubs, etc.).

(b) If the density of the polluting agent is higher than 1 it will sink down to the bottom and should be either sucked out or treated at the bottom with active coal or any other product which will check it.

Transit period of the polluting agent: to be determined.

3. Polluting agent

(a) Sampling

Use clean glass containers;
Collect:
- 20 litres of water for pesticides;
- 1 litre for heavy metals;
- a few ml of the concentrated product for identification and verification;
- 1 kg of soil;
- fauna and flora.

NB: The samples for analysis purposes should reach the laboratory in less than 24 hours.

(b) Analysis

Identification in the field favoured;
time: 24 hours out of 24;

Analytical techniques:
- Chromatography, gas phase (GC) which can be coupled to an MS;
- Chromatography, liquid phase (HPLC) identification and determination (KOW);
  - Mass spectrography;
  - Tracking of product for identification.

(c) Toxicity tests

Microtox, poison test, etc.

4. The station

- Coprecipitation and absorption are favoured.
- Biodegradation and oxidation: do not eliminate the product but only modify its molecules.

5. Wells and drilling points

Case 1: contaminated soil: dispose of soil;
Case 2: contamination from surface water: use protection system to shield the water table;
Case 3: resource waters contaminated: use mobile treatment unit to depollute.

6. Network

If the polluting agent is:
- Hydrofile: clean up network then disinfect;
- Hydrophobe: remove polluting agent or replace mains.

C. CRISIS MANAGEMENT

1. Definition

Lack of means:
- analytical means;
- treatment: unit not adapted.

Who sets off the crisis?
- The administrative authority: the Governor;
- the water distributor and/or producer.

2. Consequences

Partial or total lack of water.

3. Solutions

Lack of drinking water
- Selective shut downs (information):
  - Knowledge of the network plans;
  - Importance of selection: hospitals, small scale daily food suppliers, industries, security, fire-brigade, etc.
- Prohibition of certain utilizations;
- Reduction of pressure;
- Alternating shut downs;
- Distribution with delegation:
- Authorized opinion (expert committee);
- information needs;
- setting-up of crisis hit team.

Total lack of water
- General shut down of water:
  - Shut down information: media information (to avoid panic) and population information (stick to existing systems).
  - Derogation information: by a specialist (spokesman)
- Distribution organization:

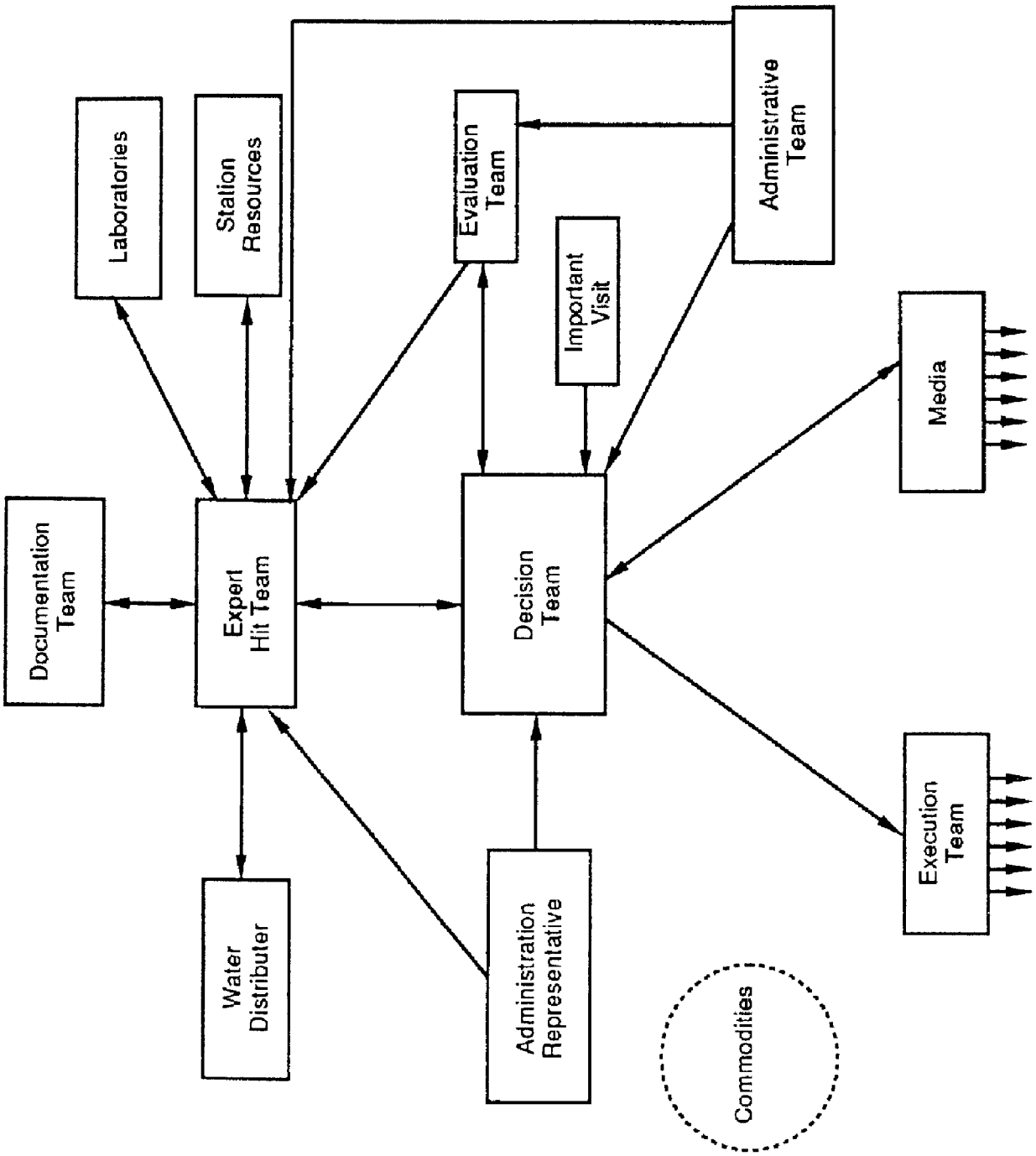


Fig. 1 Crisis hit team

To identify:
- neighbouring water resources;
- private wells in use or potentially usable;
- bottled water;
- listing of operational water containers for transportation or storage;
- container cleaning and disinfection procedure;
- types of receptacles for carrying water to the houses;
- the human means for the transportation and management of water distribution.
- Quality derogation

The expert hit team comprises:
- health experts, toxicologists;
- treatment experts;
- expert hydrologists;
- analysis experts;
- administration experts;
- distribution experts;
- irrigation experts.

The expert hit team should be regularly activated.

Decision hit team comprises administration representatives:
The State:
- the Governor;
- Ministry of Interior (civil defence, gendarmerie, police.);
- Ministry of Defence;
- Ministry of Health;
- Ministry of Agriculture;
- Ministry of Public Works;
- Ministry of Transportation;
- Ministry of Industry and Commerce;
- Ministry of Information (spokesman).

Other than the administration:
- Water producers;
- Water distributors;
- Users: Municipal council.

Crisis hit team needs (Fig. 1):
- Telephone (special lines), fax, telex, and radio;
- Means of control of media;
- Financial reserves: exceptional expenditure.

SAUDI ARABIA

EMERGENCY PREPAREDNESS

I.S. Azouni

1. INTRODUCTION

Although no specific disaster or emergency situation has occurred in Saudi Arabia in the recent past, the country has a system formulated to face a potential disaster or emergency.

The main objective of disaster/emergency measures is to maximally prevent casualities, injuries and damage to the community affected in the minimum possible time. This should be possible if pre-disaster preparations are well planned, disaster relief activities designed for maximum effectiveness and post-disaster relief and rehabilitation measures follow.

All disasters, whether natural (e.g. earthquakes, volcanic eruption, floods) or man-made (e.g. wars, industrial or chemical accidents), require coordination and cooperation between different departments and sectors. Interdepartmental coordination and intersectoral cooperation are a must for effective relief measures. The extent of the role of any one department or sector may vary in different situations, but coordination and cooperation is essential if the system is to operate smoothly and if the department that faces the brunt of the disaster is to be relieved of some of its load. The organizational structure of the emergency preparedness system existing in Saudi Arabia is described below.

2. ORGANIZATIONAL STRUCTURE

The Regional Disaster/Emergency Committee has one representative from all the main primary and secondary auxiliary authorities. The Main First-line Authorities consist of:

- Civil Defence
- Saudi Red Crescent
- Police
- Electricity Company

supported by the auxiliary authorities.

The Primary Auxiliary Authorities consist of:

- Municipality Corporation
- Department of Health
- Department of Water and Drainage
- Department of Traffic
- Police

The Secondary Auxiliary Authorities consist of:

- National Guard
- Military Command Force
- Intelligence Department
- Finance Department Branch
- Commerce Department Branch

- Public Transport
- Vocational Training Centre
- Educational Department

3. OPERATIONAL ROLES

3.1. Pre-disaster preparation

Pre-disaster preparation is carried out to prevent wastage of precious time between the onset of disaster and initiation of relief activities. Such preparation may involve the following:

(a) Places which pose a high risk or potential for disaster are determined;

(b) A comprehensive map showing the location of high-risk places is prepared, showing road-links between different establishments, hospitals, civil defence centres, fire brigade station and other disaster relief institutions;

(c) Evacuation assembly points (peripheral as well as central) are marked to facilitate evacuation of the community in an organized way;

(d) Plans are made to transport casualties to hospital in the minimum possible time;

(e) A permanent communication network is to be made available between authorities participating in disaster relief;

(f) A warning/alarm system is set up to alert the community at risk when necessary, to inform them of the proper action to be taken and not to panic.

3.2. Disaster relief activities

Disaster relief activities are carried out by main first-line authorities supported by the auxiliary authorities. A quick look into the nature of the disaster and gravity of the situation is made and relief activities are triggered and modified accordingly. Among the relief authorities, civil defence faces the main thrust of the disaster/emergency.

3.2.1. Role of main first-line authorities

(a) Civil defence authorities communicate without delay with other first-line authorities and auxiliary authorities according to the nature of disaster. Civil defence immediately establishes a control headquarters at the disaster site and nominates a team leader who controls the activities of other first-line, as well as auxiliary authorities, so that activities flow in an organized way. Civil defence makes essential announcements to alert the affected community at risk and to guide them in evacuation and other essential measures. Civil defence, in coordination with other departments, makes essential arrangements for evacuation and required transport.

(b) Saudi Red Crescent provides transport and first-aid care to the casualties and evacuates them to medical units.

(c) Police maintain law and order.

(d) Electricity department cuts off electricity if necessary.

3.2.2. Role of auxiliary authorities

The auxiliary authorities (primary as well as secondary) support the main first-line authorities and play their role according to the nature of their responsibilities. The role of auxiliary authorities can be summarized as follows:

- to provide shelter to the affected community;
- to provide safe water by tanker to the affected community;
- to provide safe food to the affected community;
- to provide essential sanitation facilities;
- to arrange safe disposal of waste by burial;
- to prevent insect and rodent infestation;
- to provide essential preventive health services as regards chemoprophylaxis, immunoprophylaxis and related preventive care;
- to provide curative health services to the community;

For example, the city of Madina Munawara has capacity to accommodate an additional 4000 patients via:

- Three major hospitals which form a first-line reserve and can accommodate 750 emergency patients in addition to the routine case load;

- Other hospitals form a second-line reserve and can provide an additional 250 beds;

- Private hospitals are capable of accepting 400 patients;

- Health centres can accommodate 600 patients and six of the health centres are nominated as local evacuation points;

- If required, educational institutions can be used to accommodate a case load of 2000 additional patients.

The central blood bank in Madina has a large reserve of blood to be used in emergencies. This stock comes from voluntary and compulsory donations .

3.3. Post-disaster rehabilitation measures

These are carried out to protect the disaster-affected community from the later effects of the disaster. The essential measures cover:

- protection from infectious diseases;
- protection from malnutrition/undernutrition;
- surveillance to ensure safe water and food;
- surveillance to control environmental pollution;
- provision of better shelters;
- protection from psychological trauma;
- rehabilitation of disabled cases.

4. CONCLUSION

However well-equipped the authorities may be, a disaster/emergency relief programme cannot be effective and successful unless the following are fulfilled:

(a) Intersectoral coordination and ease of communication;

(b) Clear-cut job descriptions for each department without confusion or duplication of roles;

(c) Disaster relief drill for the responsible departments as well as the community;

(d) Provision of essential environmental health facilities to the affected community.