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Ministry of Local Administration and Environment

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Vulnerability Assessment and Possible Adaptation Measures of Health Sector in Syria

Related to the Project Activity

Programs Containing Measures to facilitate Adaptation to Climate Change

Project Title

Enabling activities for preparation of Syria's initial national Communication to the UNFCCC, (Project Nr.00045323).

National Project Director
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The project implemented in the ministry of local administration and Environment (MLAE)/General Commission of Environmental Affairs (GCEA), in collaboration with Global Environmental Facility (GEF) and United Nation Development Programm (UNDP) in Syria.

Vulnerability Assessment and Possible Adaptation Measures of

Health Sector

(INC-SY_V&A_ Health -En)

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March / 2009

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This report has been approved unanimously by the technical committee, during the Technical Workshop which took place on 24/ 03/ 2009 in the Dedeman Hotel Palmyra.

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Forward

Health sector in Syria includes many parties providing health services. The Ministry of Health (MOH) represents the main provider of these services. Other parties are:

1. The Ministry of High Education: provides health services for a big number of residents in the cities where teaching hospitals are located. Some of these hospitals are considered amongst the biggest health centers in Syria.
2. The Ministry of Defense (Military Medical Services): provides health services for members of armed forces and their families. Recently they expanded their services to include civilians as well. The ministry covers a remarkable portion of the Syrian population.
3. The Ministry of Interior: provides health services to members of internal security forces and their families. It has relatively small share of the field.
4. The private sector: includes two categories of service providers: non-profitable occupational, charity, and volunteer providers represent the first category. The profitable institutions represent the second one.

Health sector in general has prospered rapidly in the last two decades, especially the (MOH) section. This growth upgraded the classification of Syria to a remarkable position regarding health indicators fulfillment. This was made possible only through efforts of the (MOH) and the services it provides, especially in the domain of preventive medicine. The primary health care is the policy adopted by the (MOH); it focuses on prevention rather than treatment. The best illustration of this issue can be the concentration on the most important health problems: making detailed explanation of the problem and designing suitable programs to reduce its burden. Examples of those programs are plenty: the national vaccination program, the reproductive health program, health care program for senior citizens, health care for teenagers, control of communicable diseases (*Malaria, Leishmaniasis*, and *Shistosomiasis*), diarrhea control, sexually transmitted infection control, and tuberculosis prevention. All these programs are living proof of the vital role the (MOH) is taking in the domain of public health.

Very much has been done in the treatment domain which includes secondary and tertiary health care. The health sector is undergoing now a development process under the cooperation between the (MOH) and the European Union. This process is focusing on many health issues especially the development of hospital performance. Figs. (1), (2), (3), (4), and (5) illustrate the (MOH) structure with highlight of sections concerned with potential health impacts of climate change.

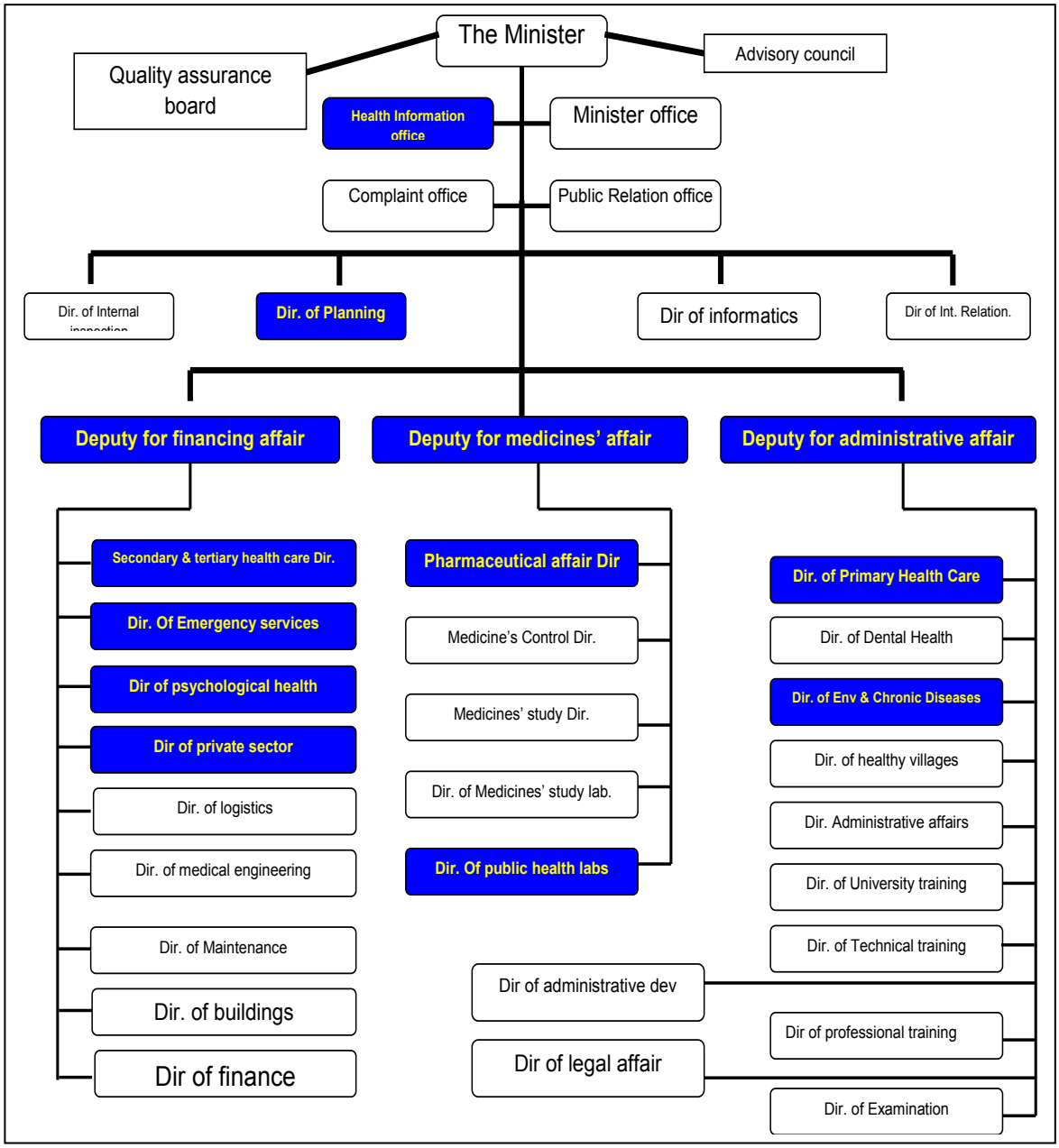


Fig. (1): Structure of (MOH) in Syria

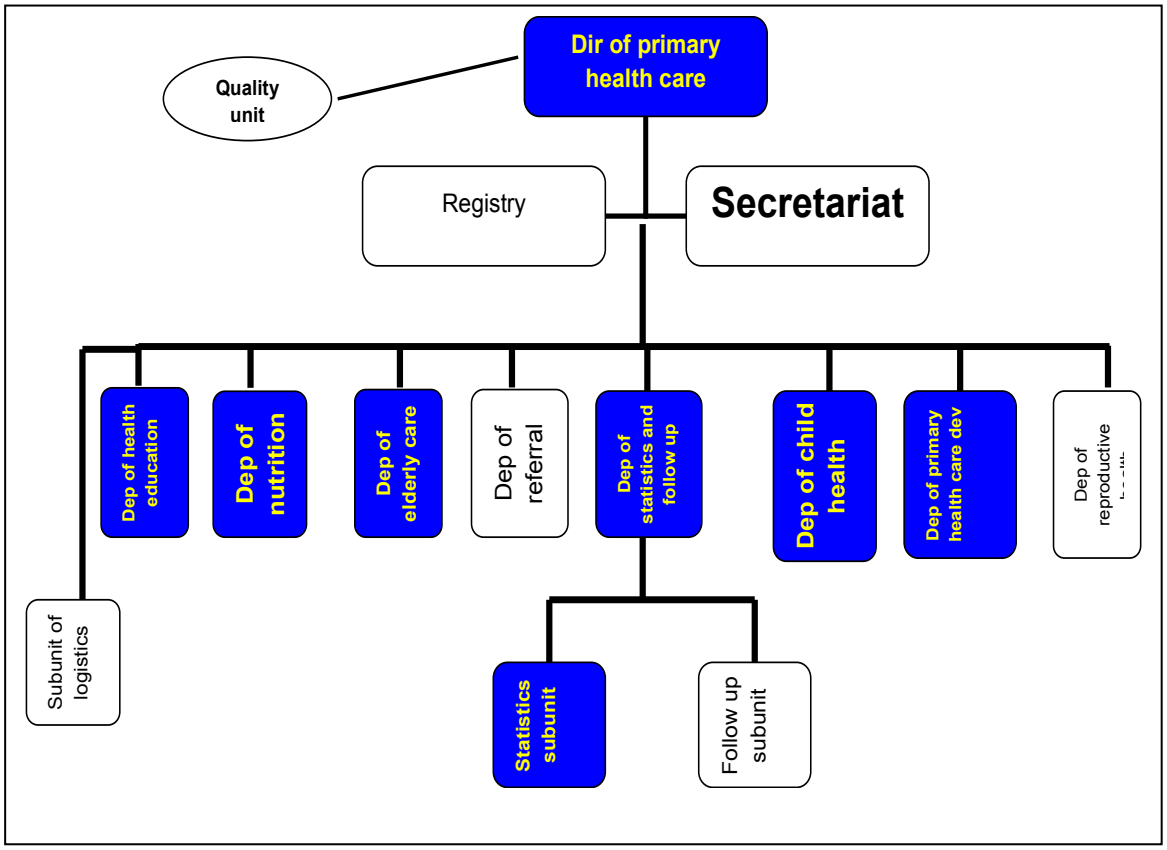


Fig. (2): Structure of the directorate of Environmental and Chronic diseases

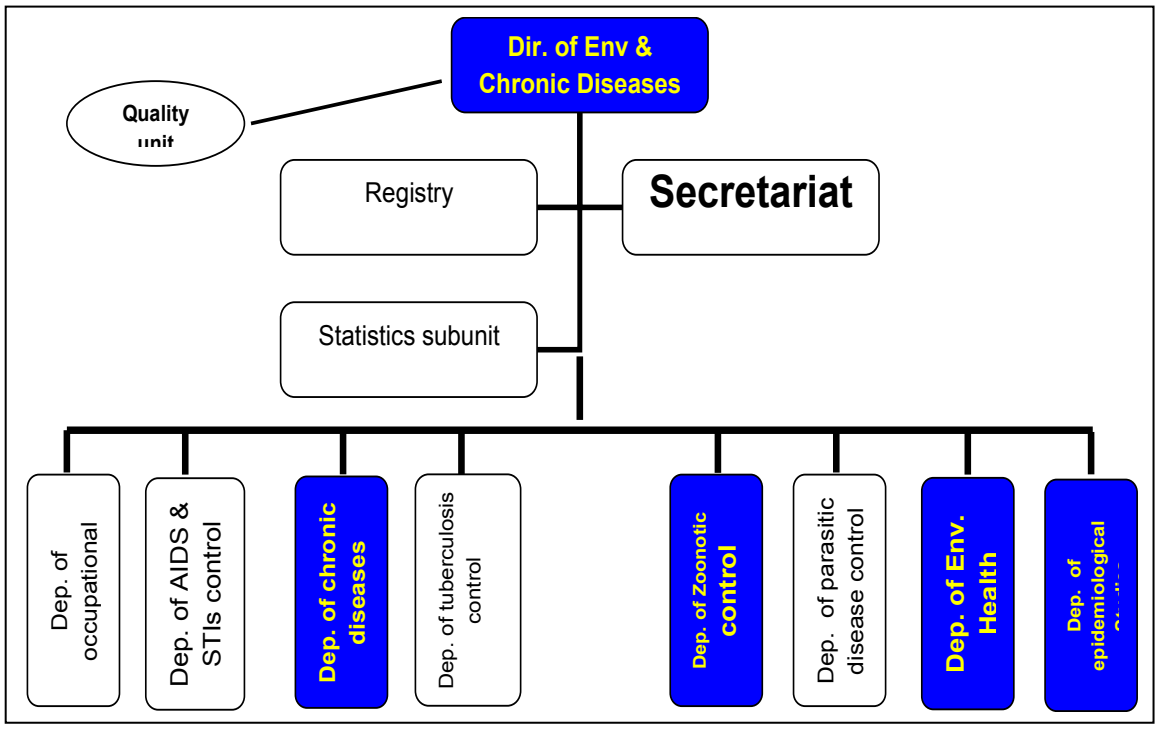


Fig (3): Structure of the directorate of Primary Health Care

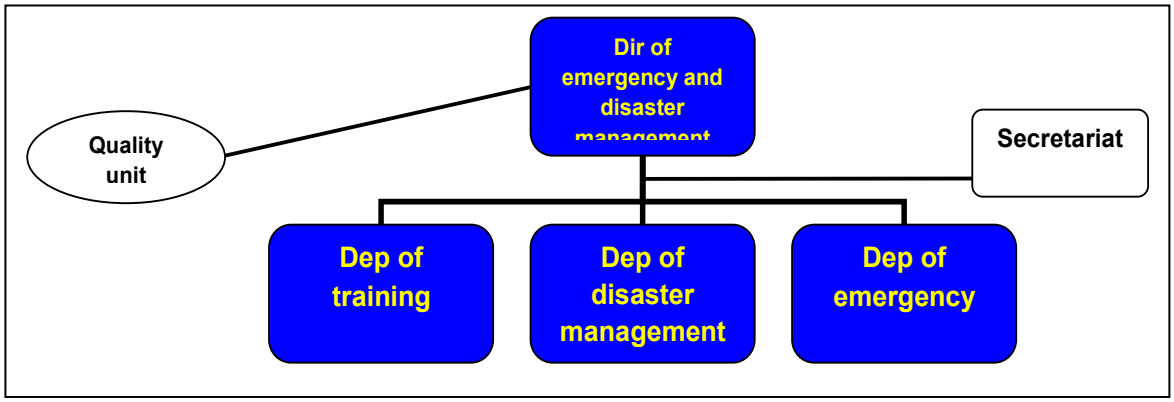


Fig. (4): Structure of the directorate of Emergency and Disaster management

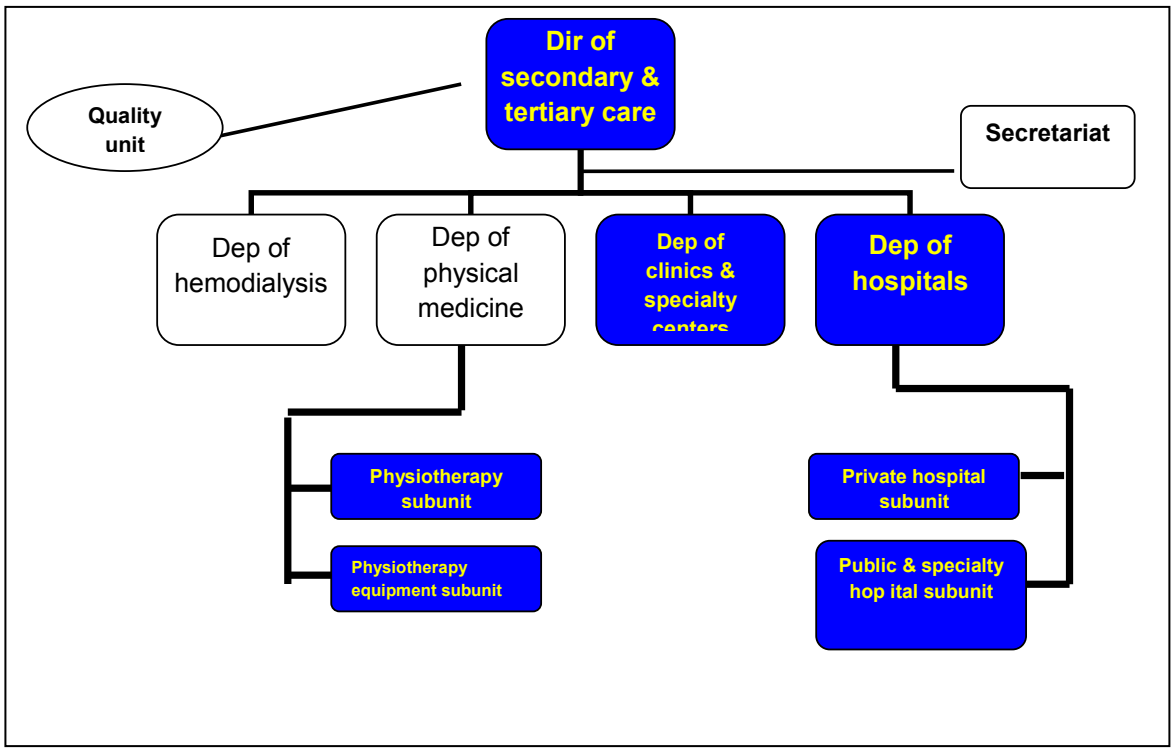


Fig. (5): Structure of the directorate of secondary and tertiary care

1. Ministry of Health (MOH) targets and tasks

Enlisted here some of the key tasks[i] executed by the (MOH):

- Comprehensive supervision of health issues, including health institutions and coordination.
- Providing health services and related logistics. The service distribution is to ensure social justice and keep up to date with global health progress.
- Prevention and control of environmental and communicable diseases.
- Implementing chronic disease prevention and control programs.
- Implementing health programs for the senior citizens.
- Promoting and developing capacities to deal with emergencies and disasters.
- Reviewing legislations and suggesting relevant modifications concerning health sector.

- Reviewing and updating health strategies, and participating in the approval process.

For information that is more detailed we can say the (MOH) aims to achieve the following objectives[1]:

1. Promoting public health and improving health indicators.
2. Controlling the drug quality, and contributing to environment and food control.
3. Focusing on reproductive health including family planning as a mainstream to population policies.

Tasks of directorates and departments related to health impacts of climate change:

A- Directorate of planning, statistics and policy support:

- Supplying information needed for health planning in coordination with relevant parties.
- Preparing health plans for the (MOH) and the health sector.
- Managing human resources in the (MOH).
- Determining the size and number of health establishments needed in the country (hospitals, centers, institutions, and nursing schools).
- Collecting statistics concerning morbidity and mortality from relevant parties.
- Analyzing the collected statistics and obtaining health indicators.
- Reviewing the results health researches in order to know disease and accident rates.

B- Directorate of Environmental and Chronic diseases:

- Preparing the annual plan, providing logistics and determining the potential backup resources.
- Acting appropriately for the protection against communicable, environmental and chronic diseases, and reducing their burden on public health.
- Implementing surveillance of environmental and chronic diseases.
- Investigating emerging epidemics and bringing them under control.
- Technical supervision on subunits working under the directorate.
- Developing human resources and implementing training programs.
- Conducting researches to improve those disease-controlling programs.

  - Environmental Health Department:
    - Participating in assessing environmental problems and locating disease sources in the environment in collaboration with other interested parties.
    - Conducting specific field studies on environmental pollution and the impact it has on public health, then making suitable proposals and alternative plans.
    - Participating in designing standards and systems regarding environment safety in collaboration with relevant parties.
  - Epidemiological investigation and emerging disease prevention department:
    - Improving epidemiological surveillance and preparing the guidelines.
    - Surveillance of emerging diseases, preparing plans to bring them under control, and supplying needed logistics.
    - Technical supervision of communicable diseases in hospitals regarding regulation, equipments, staff training, and preparedness for emergencies.
    - Collecting and analyzing information on epidemiological surveillance, and preparing relevant reports.
    - Collaboration with public authorities regarding food safety.

- Parasitic disease control department:
  - Receiving statistics on parasitic diseases and their geographical distribution in governorates and districts. Preparing plans for control and prevention of those diseases and their vectors.
  - Providing treatment and logistics. Training health staff regarding improving performance and follow up.
  - Assessing sand fly concentration and the existence of reservoir animals (rats, foxes, dogs …etc.), and their places. Preparing maps of vector and reservoir animals periodically.
  - Implementing insect pickup traps, and improving skills needed for specimen collecting, typing, and dissecting.
  - Identifying areas that are to be targeted by prevention program early each year, and assessing land areas that will be sprayed with pesticides.
  - Assessing pesticide quantities and other needed equipment and providing logistics. Evaluating pesticide efficacy in labs and in the field. Conducting studies regarding household pesticides.
  - Technical supervision of central and peripheral pesticide warehouses and their contents, and preparing relevant documentation.
  - Preparing budgets for spraying campaigns and the share dedicated to different parties. Providing direct supervision of campaigns, and then studying the results and the efficacy, finally preparing relevant reports.
- Chronic non communicable disease department:
  - Surveillance of chronic diseases and contributing to conducting relevant health surveys and studies.

C- Directorate and departments of primary health care:

- Suggesting relevant health policies, strategies and systems in the field of primary health care.
- Preparing the directorate action plan, providing logistics, and deciding on the work share of other parties.
- Preparing primary health care programs and supervising their implementation and follow up. The directorate supervises also health services provided at health centers, and work on spreading the concept of primary health care.
- Designing the best methods to promote active contribution of the community in planning and implementing the activities of health care.
- Taking part in conducting studies needed for better understanding the health situation and to develop health systems regarding primary health care.

D- Directorate and departments of secondary and tertiary health care:

- Assessing the needs of public and specialized hospitals, and following up its activities.
- Assessing the real needs regarding medical equipments and supply required for efficient work of health establishment, then referring the results to concerned parties.
- Studying reports issued by health directorates and hospital panels to solve their problems.
- Periodic inspection of private hospitals to ensure good quality performance and high commitment to health legislations and systems.
- Assessing the real needs regarding medical equipments and supply required for comprehensive clinics.

- Issuing licenses for people willing to work in the medical field whether individuals or establishments including medicine and medical equipment import trade.
- Follow up of the performance of comprehensive clinics and specialized centers in coordination with relevant parties.

E- Directorate of emergency and disaster management:

- Assessment of services needed for the community regarding emergency and protection, and designing suitable national programs.
- Participating in emergency and disaster management planning, follow up, and working to ensure the availability of required staff, equipments, and medicines.
- Building capacities for human resources in the field of emergency and disaster management.
- Supervising the communication network regarding development, preparedness, and follow up.
- Supervising and participating in field trial related to emergency and disaster management.
- Conducting statistical studies on emergency cases to obtain the useful results.
- The directorate includes 3 departments: department of emergency, department of disaster management, and department of training.

  Tasks of department of emergency:

  1. Keeping the preparedness of developed communication network to facilitate communication between citizens and centers that receive the calls.
  2. Follow up ambulance vehicle preparedness in coordination with health directorates for the sake of preserving prompt response.
  3. Follow up the preparedness of centers that receive emergency cases and provide treatment.

  - Tasks of department of disaster management:
    - Participating in the planning process for disaster management, and insuring that disaster warehouses and boxes in health directorate are well prepared.
    - Follow up the preparedness of disaster management teams.
    - Coordinating with relevant parties in order to design inter-sectorial plans that guarantee smooth coordination in case of emergencies.
    - Follow up preparedness and efficacy of equipment, medicine, and disaster management warehouses.
  - Tasks of the department of training:
    - Participating in the planning process for disaster management, and ensure the preparedness of warehouses and funds on health directorate level.
    - Spreading the emergency culture and the best response needed among targeted groups.

2. Preparedness of health sector

2.1. The Ministry of Health

The review of regulating legislation, decrees, acts, and rules that guide and control the work of the (MOH) reveals that they are capable of dealing with any health situation may arise from the climate change, since no new diseases are expected to occur but remerging of old diseases or deterioration of existing ones that could spread to more locations.

Health centers: The wide horizontal spreading of health services could meet the needs of preparedness and adaptation required. It should be noticed, nevertheless, that the service quality, most of the time, is not up the satisfaction level regarding accuracy of diagnosis, availability of medicines, the link between environmental factors and health output, and focusing on community health concepts and infrastructure.

Emergency system: No precise information are available to evaluate how efficient this system is. In order to know more details solid studies should be conducted concerning the real situation of the system.

Disaster management system: The analysis of *Zeizoon* dam breakdown showed loss of ready disaster management plan leading to waste of time and efforts, and to duplication of tasks implemented by various parties. Therefore, it is of utmost importance to set such plan in every governorate according to the real needs, danger sources, and the expected type of disasters. This plan should be documented, published, and well known by each and every participant party, including the (MOH), ensuring a sectoral assignment of duties.

Medicine supplies: It is essential for specific medicines to be available in high risk and borderline areas. These medicines should cover diseases affected by climate change such as malaria, bilharzias, and leishmaniasis especially the visceral type. The actual situation of some of these disease absences does not guarantee against reemergence in the future, hence the necessity to act appropriately in case some existing or imported old diseases cause epidemics (Dengue fever, Avian Influenza, or Cholera etc.) under suitable environmental and climatic conditions.

Legislations: The public health law is considered as the comprehensive statute for all the public health issue. Lack of this law in Syria is a big draw-back, hence the importance of establishing it in a way that makes it flexible enough to deal with emerging situations related to the protection of citizen health against the health impacts of climate change.

2.2. The Ministry of Higher Education:

The *Mouassat*[ii] teaching hospital in Damascus is considered an example of a big health center operating under the ministry authority.

- Central emergency department: with 18 beds deals with the following medical specialties: internal medicine, general surgery, ophthalmology, (ENT; Ear Nose and Throat), and burns.
- 4th floor Emergency department (surgical): has about 70- 80 beds.
- 5th floor Emergency department (internal medicine): has about 80- 90 beds.
- Cardiac intensive care unit, pulmonary intensive care unit, surgical intensive care unit: Have 40 beds.
- Burns' subunit.

3. Health indicators[2]

Syria is considered among countries enjoying good citizen health status regarding adopted health indicators. It is now about to be declared free of some vector born diseases. Infant, child and maternal mortality rates are declining constantly, whereas life expectancy is increasing. Some health indicators are enlisted here:

- Infant mortality rate (per 1000 live births) in Syria over the years 1970- 2005, Fig. (6).

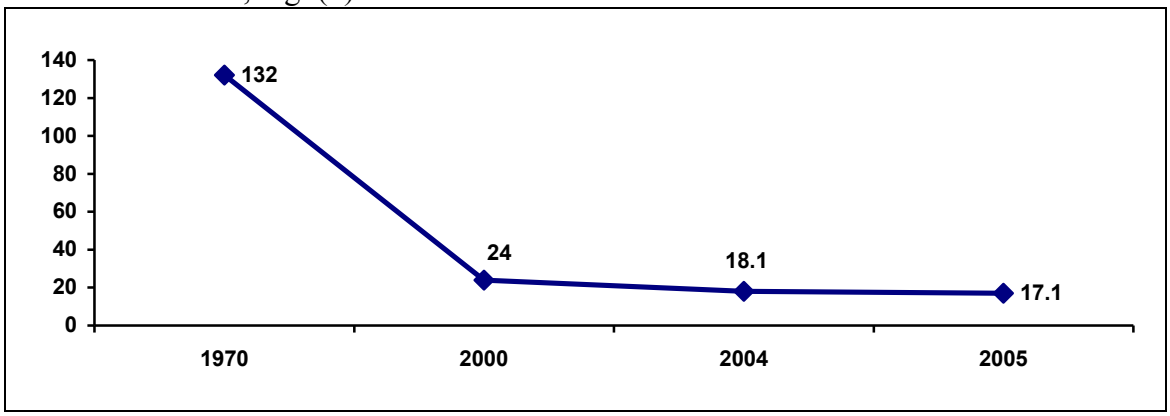


Fig. (6): Infant mortality rate (per 1000 live births) in Syria over the years 1970-2005

- Mortality rates children under five (per 1000 live births) in Syria over the years 1970-2005, Fig. (7).

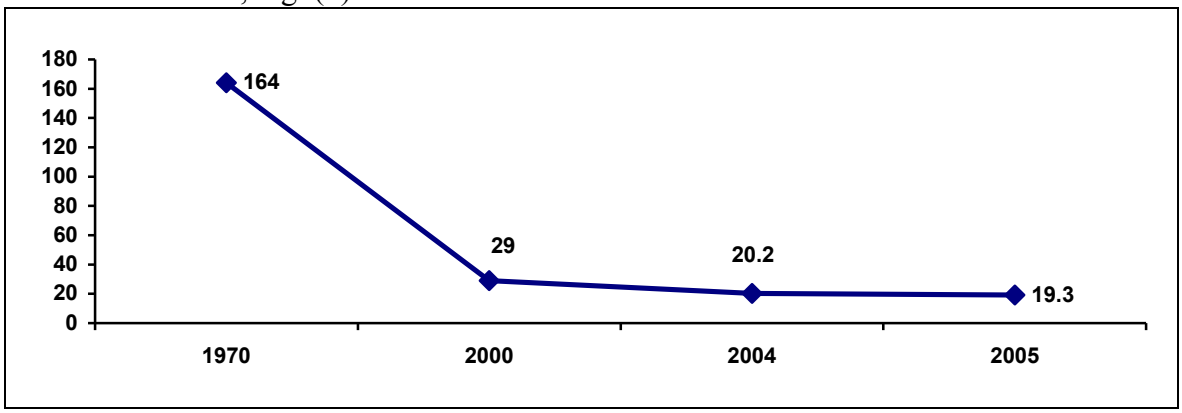


Fig. (8): Children under five mortality rate (per 1000 live births) in Syria over the years 1970- 2005

- Maternal mortality rate (per 100.000 live births) has decreased in Syria over the years 1970- 2005, Fig. (9).

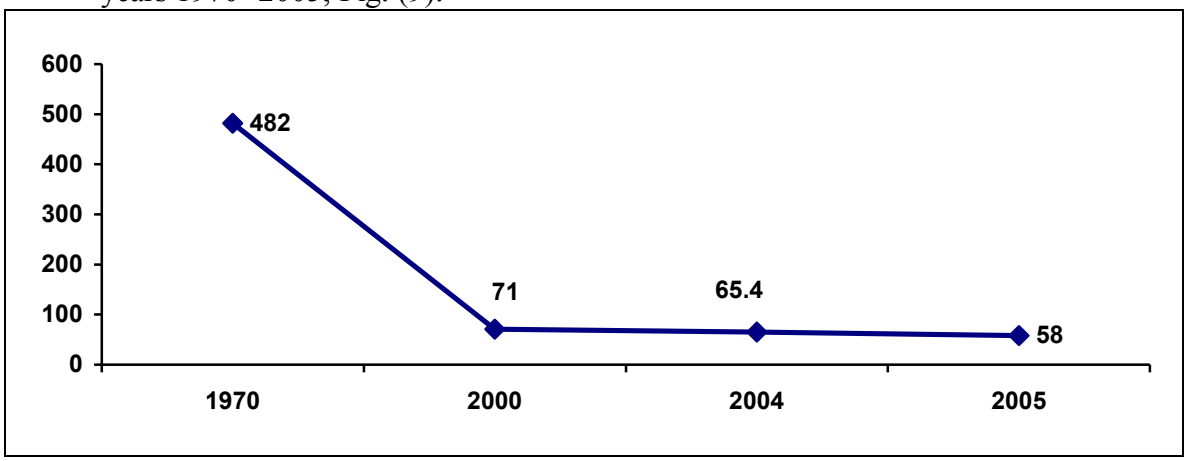


Fig. (9): Maternal mortality rate (per 100.000 live births) in Syria over the years 1970- 2005

- Life expectancy at birth (years) has increased in Syria over the years 1970-2005, Fig. (10).

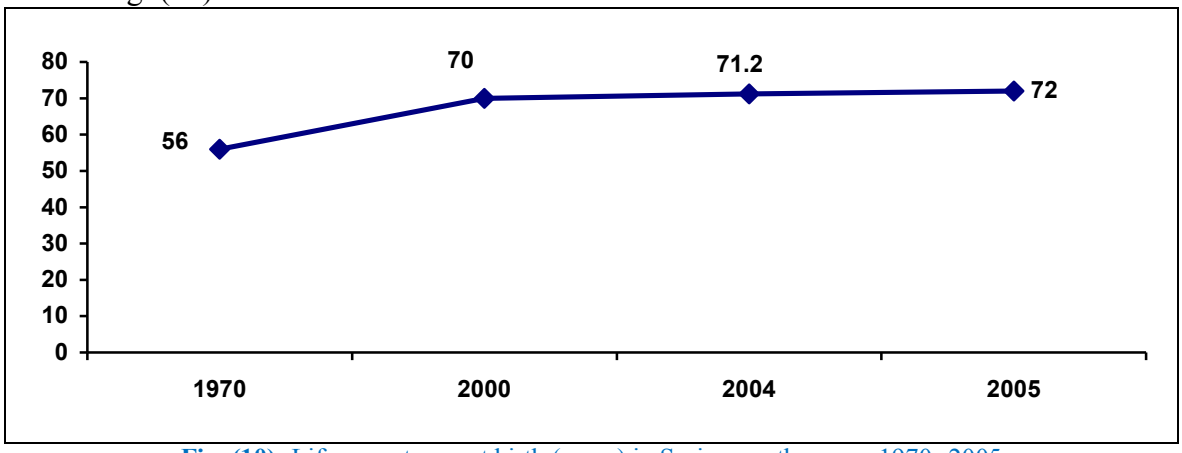


Fig. (10): Life expectancy at birth (years) in Syria over the years 1970- 2005

- Percentages of facility coverage among population (rural and urban) in Syria in 2005, Fig. (11).

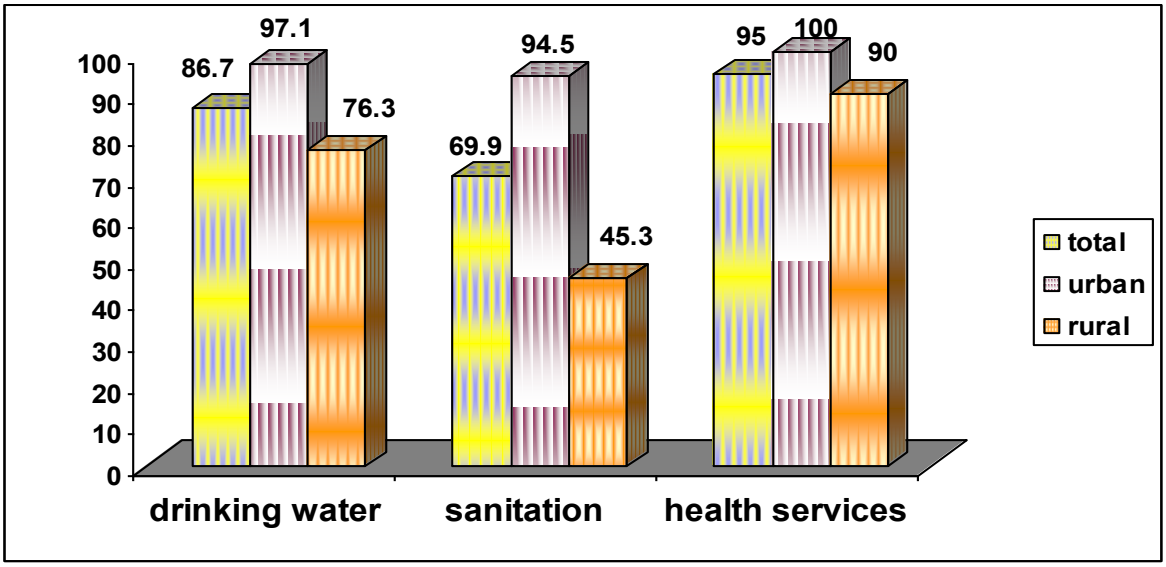


Fig. (11): Facility coverage percentage among population (rural, urban) in Syria in 2005

The (MOH) indicators:

- Health human resources (per 10.000 persons) in Syria in 2005 are presented in Fig. (12).
- The (MOH) work force has steadily increased during the period 2000- 2005, Fig. (13).
- Medical staff numbers in Syria during the period 1970- 2004, are presented in Fig. (14).
- Work force in (MOH) health centers in Syria in 2005 (100 physician, 100 dentist, 100 technician, 1000 nurse and midwife, 100 administration), Fig. (15).
- Work force in (MOH) hospitals in Syria in 2005 (100 physician, 100 dentist, 100 technician, 1000 nurse and midwife), Fig. (16).
- The size of health services provided by (MOH) divisions in Syria over 1970-2005, Fig. (17).
- Numbers of (MOH) hospitals in Syria over 1970- 2005, Fig. (18).

- Numbers (MOH) hospital beds over 1970- 2005 in Syria, Fig. (19).
- Average population per hospital bed over 1970-2005 in Syria, Fig. (20).
- Numbers of patients admitted to (MOH) hospitals in Syria over 1970- 2005, Fig. (21).
- Numbers of surgical operations performed in Syria over 1970- 2005, Fig. (22).
- Numbers of emergency services provided in Syria, over 1970- 2005, Fig. (23).
- Comparison between hospitals in the (MOH) and the private sector regarding their numbers and beds in Syria in 2005, Fig. (24).
- Evolvement of pharmaceutical sector (local brands= 100, imported brands= 1000) in Syria over 2000- 2005, Fig. (25).
- Rate between local and imported drugs in Syria over 1970- 2005, Fig. (26).

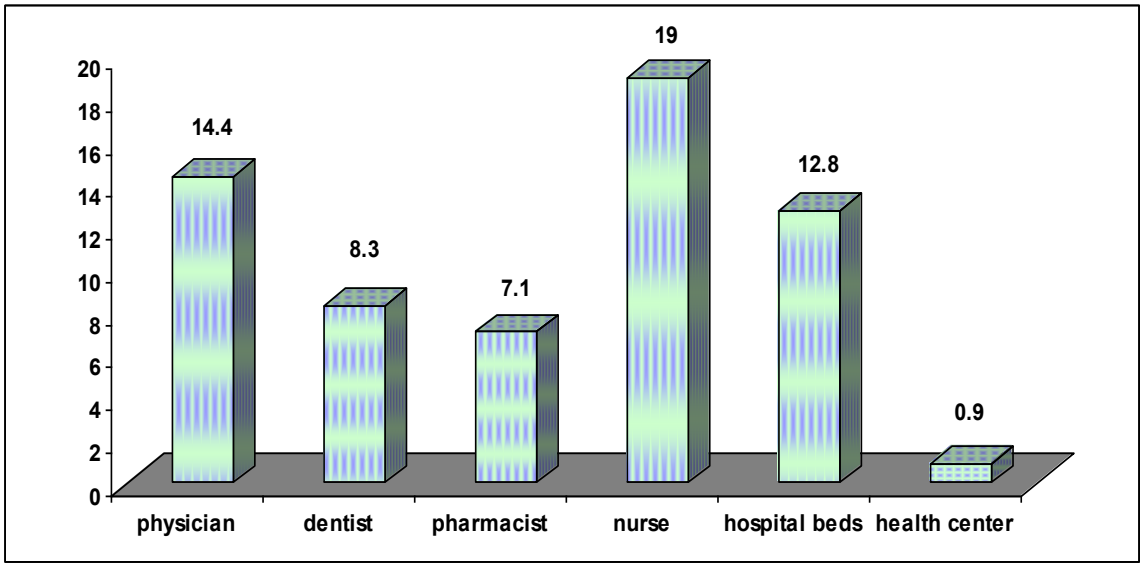


Fig. (12): Human resources (per 10.000 persons) in Syria in 2005

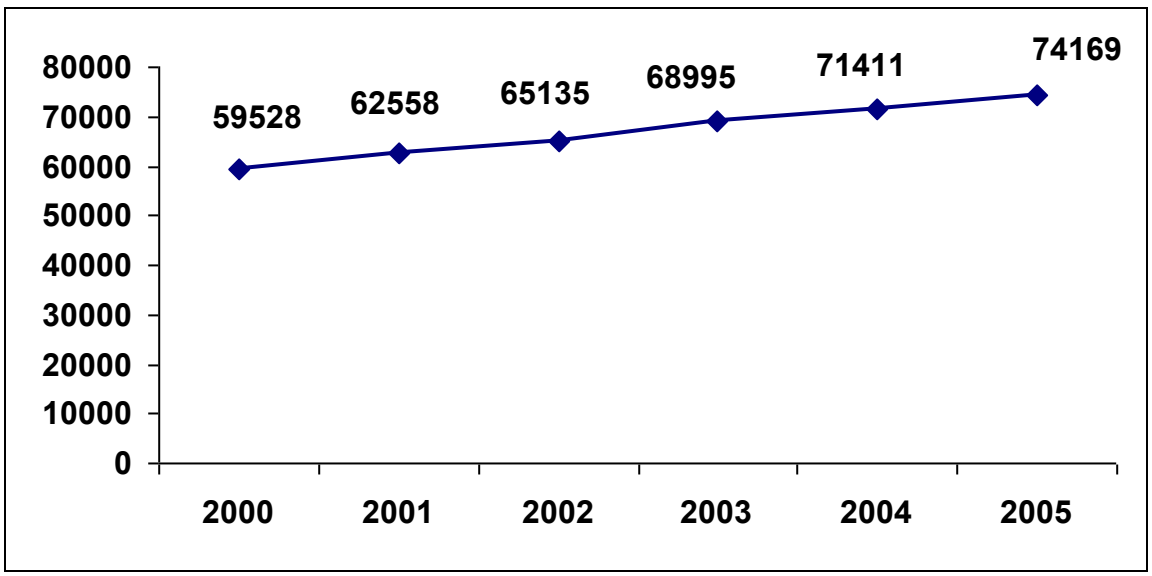


Fig. (13): The (MOH) work force over 2000- 2005

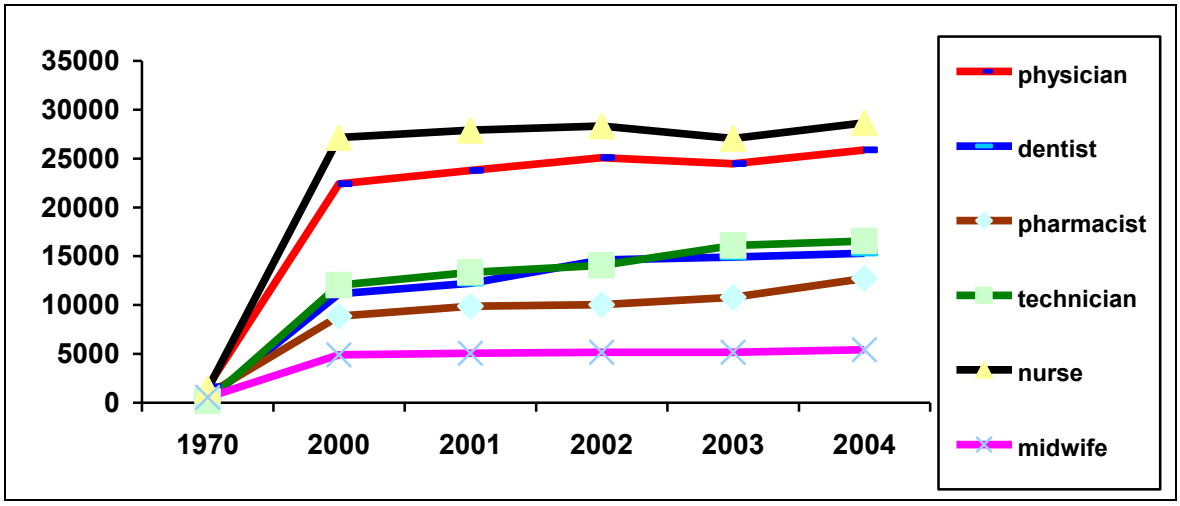


Fig. (14): Medical staff numbers in Syria over 1970- 2004

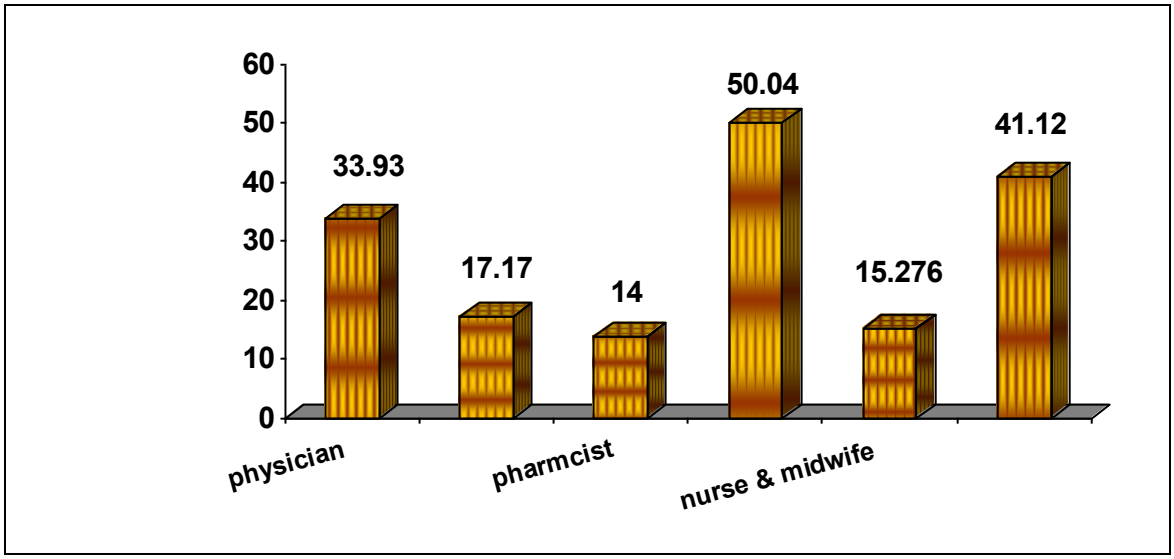


Fig. (15): Work force in (MOH) health centers in Syria in 2005 (physician= 100, dentist= 100, technician= 100, nurse and midwife= 1000, administration= 100)

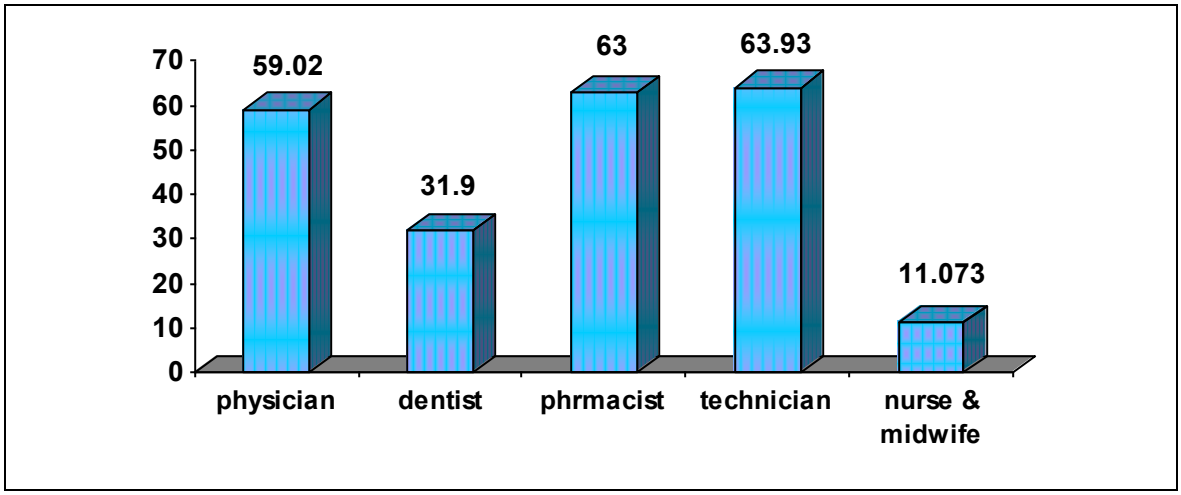


Fig. (16): work force in (MOH) hospitals in Syria in 2005
(physician= 100, dentist= 100, technician= 100, nurse and midwife= 1000)

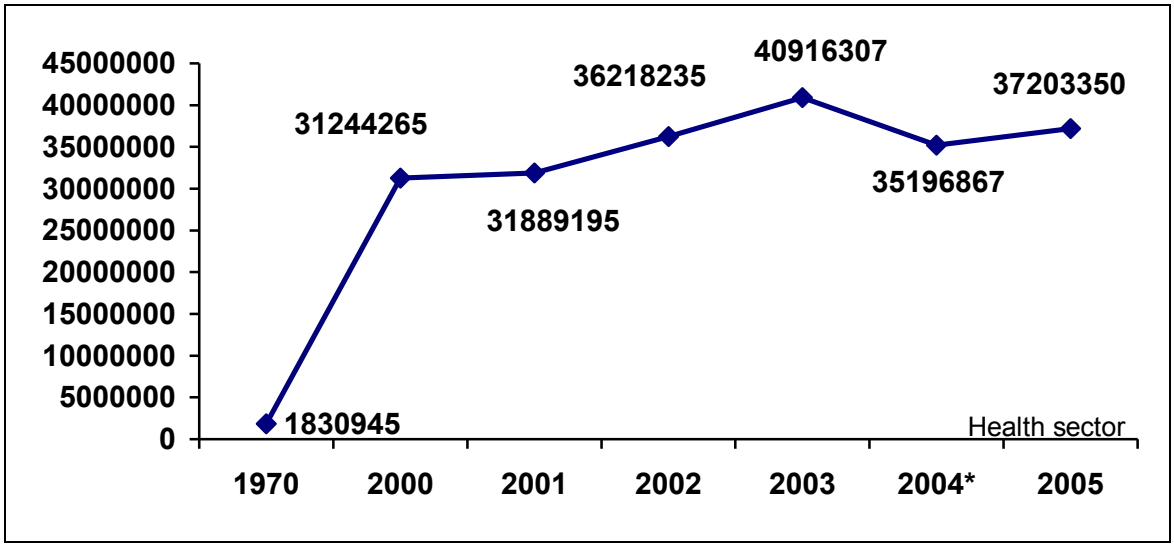


Fig. (17): The size of health services provided by (MOH) divisions in Syria over 1970- 2005
(the health services' size went down in 2004 under the influence of local vaccination campaign implemented earlier that year)

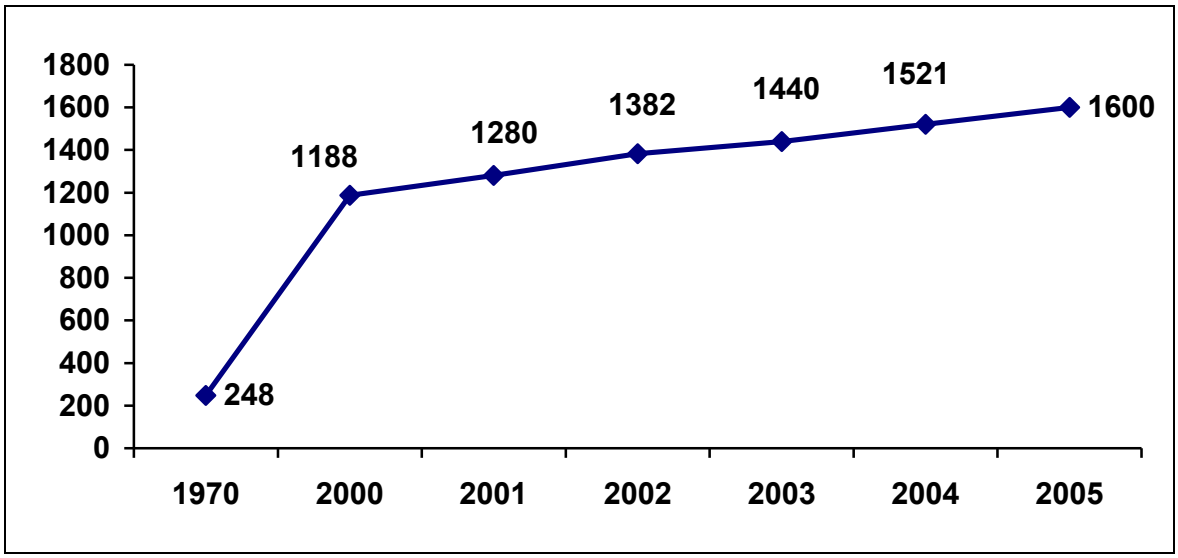


Fig. (18): Numbers of (MOH) health centers over 1970- 2005
(health center, medical post, specialty center, comprehensive clinics)

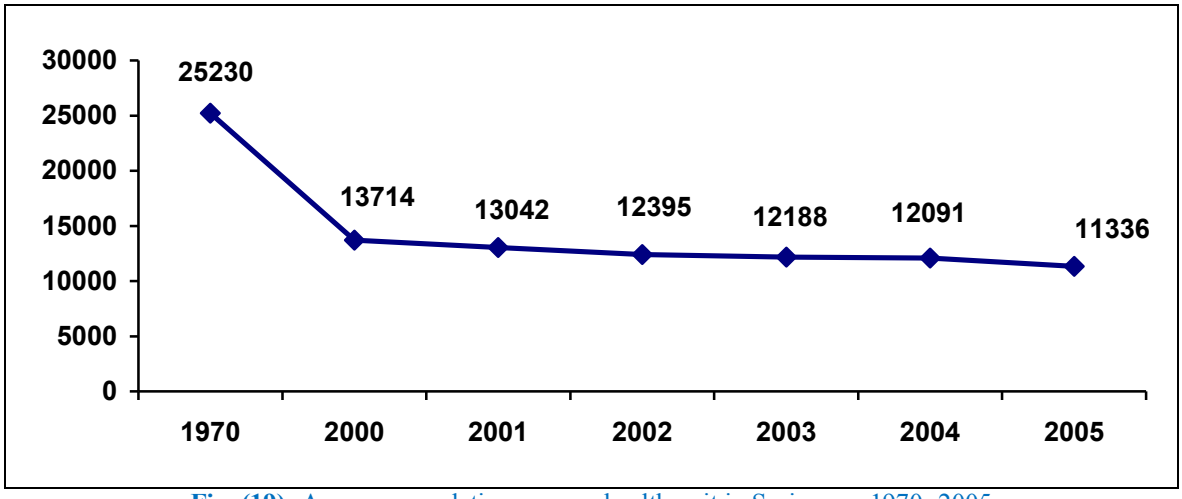


Fig. (19): Average population per one health unit in Syria over 1970- 2005

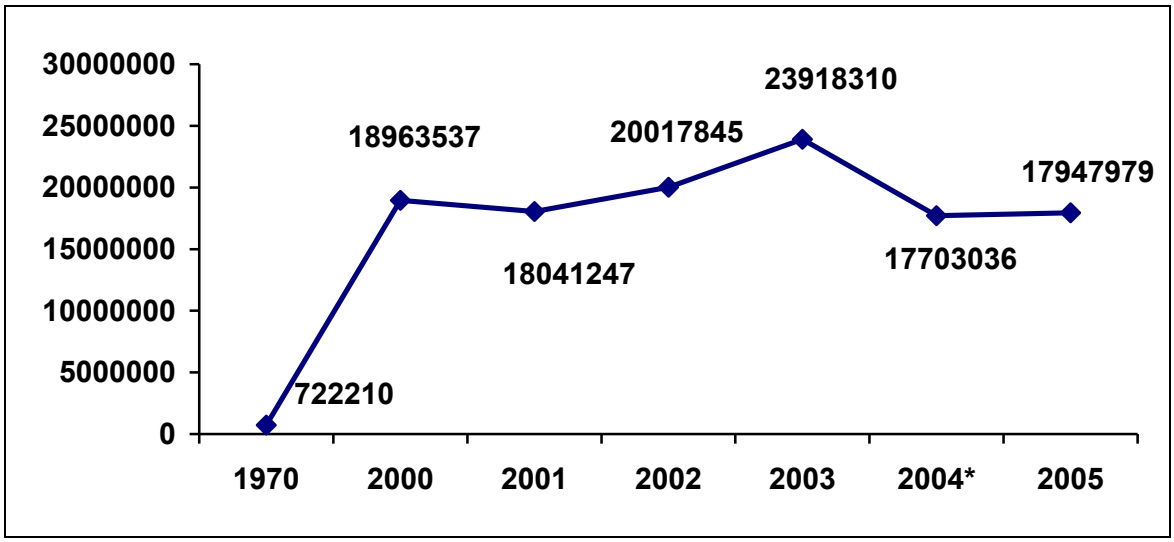


Fig. (20): The size of services provided by (MOH) health centers in Syria over 1970- 2005
(The health service size went down in 2004 under the influence of local vaccination campaign implemented earlier this year)

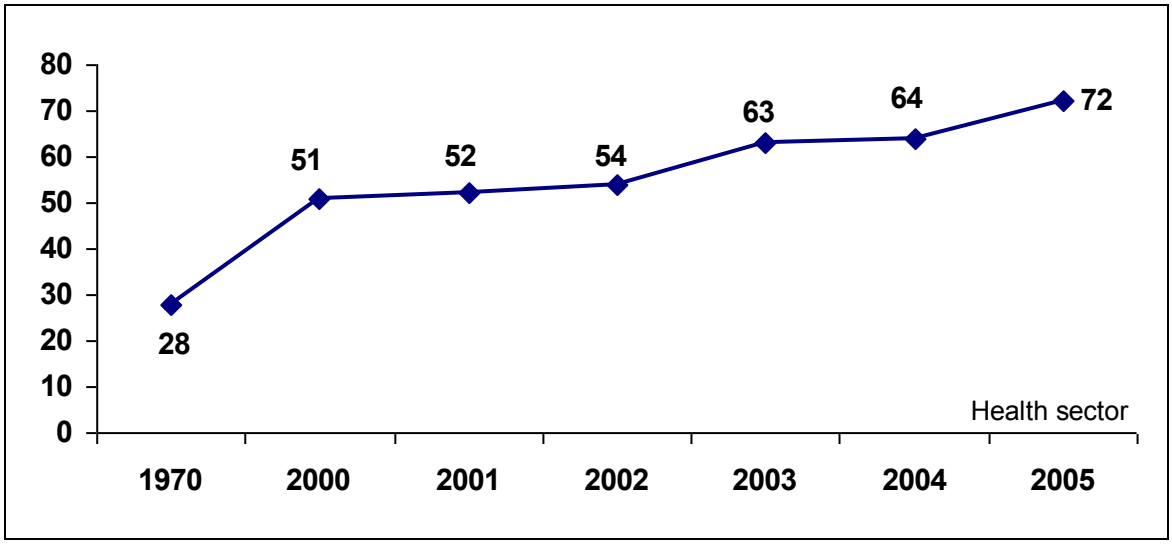


Fig. (21): Numbers of (MOH) hospitals in Syria over 1970- 2005

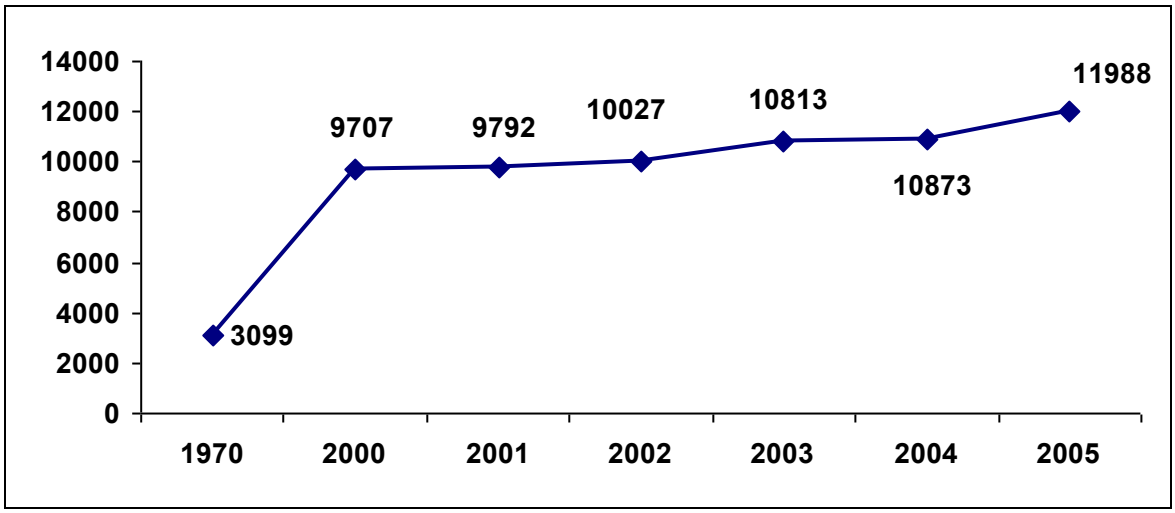


Fig. (22): Numbers of (MOH) hospital beds over 1970- 2005 in Syria

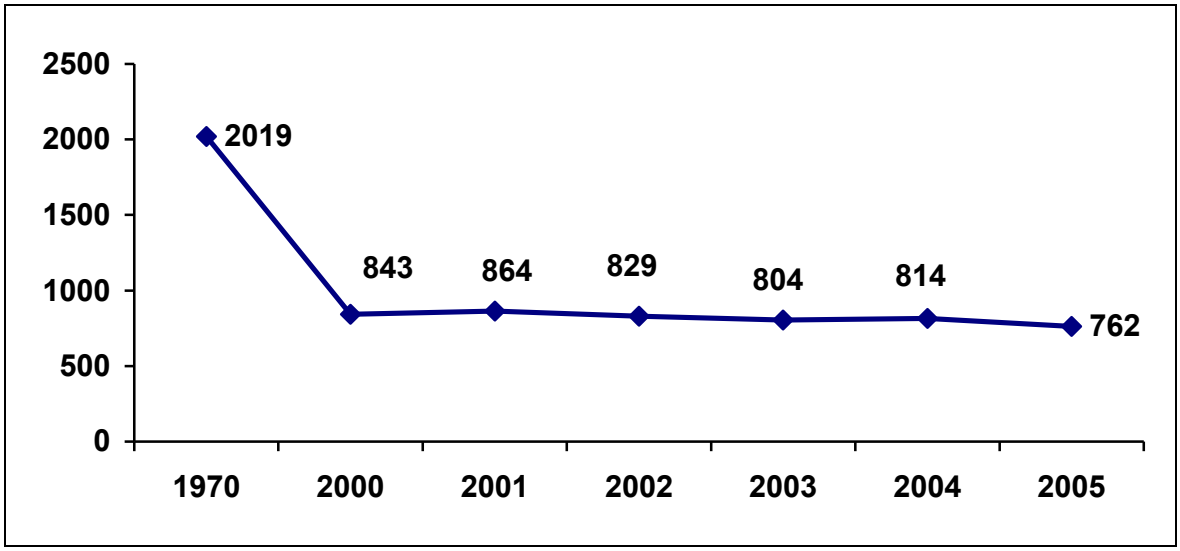


Fig. (23): Average population per hospital bed over 1970- 2005 in Syria

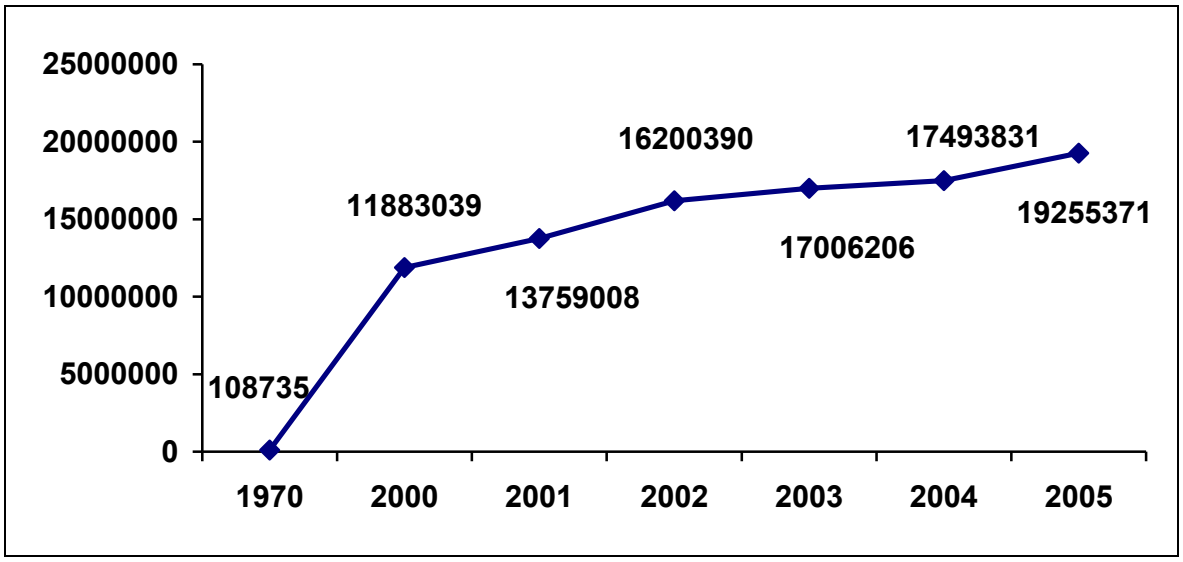


Fig. (24): Numbers of patients admitted to (MOH) hospitals in Syria over 1970- 2005

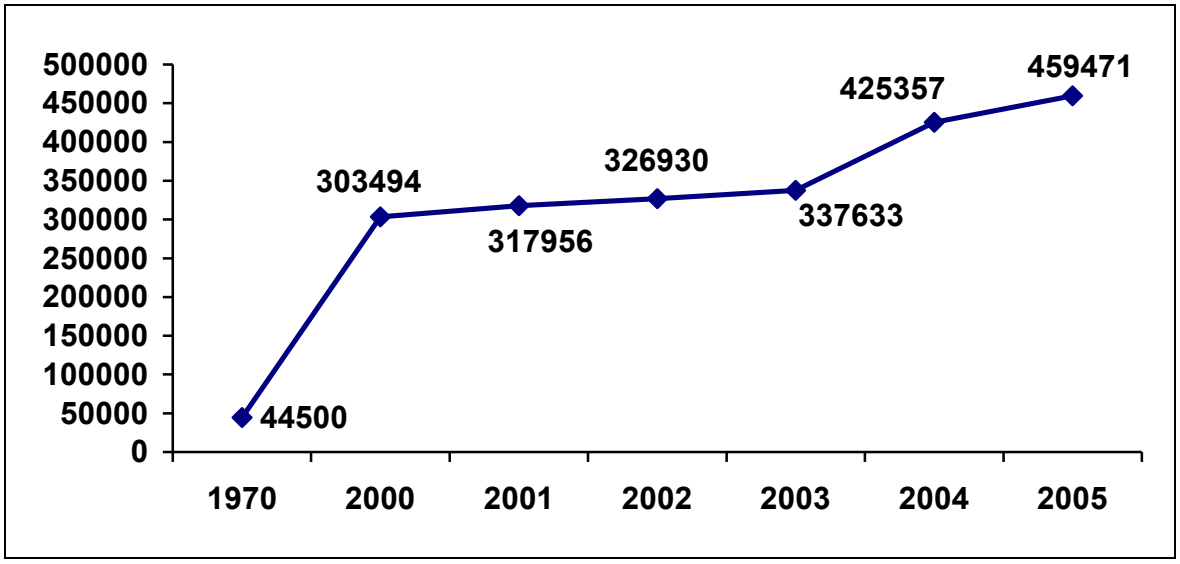


Fig. (25): Numbers of surgical operations performed in Syria over 1970- 2005

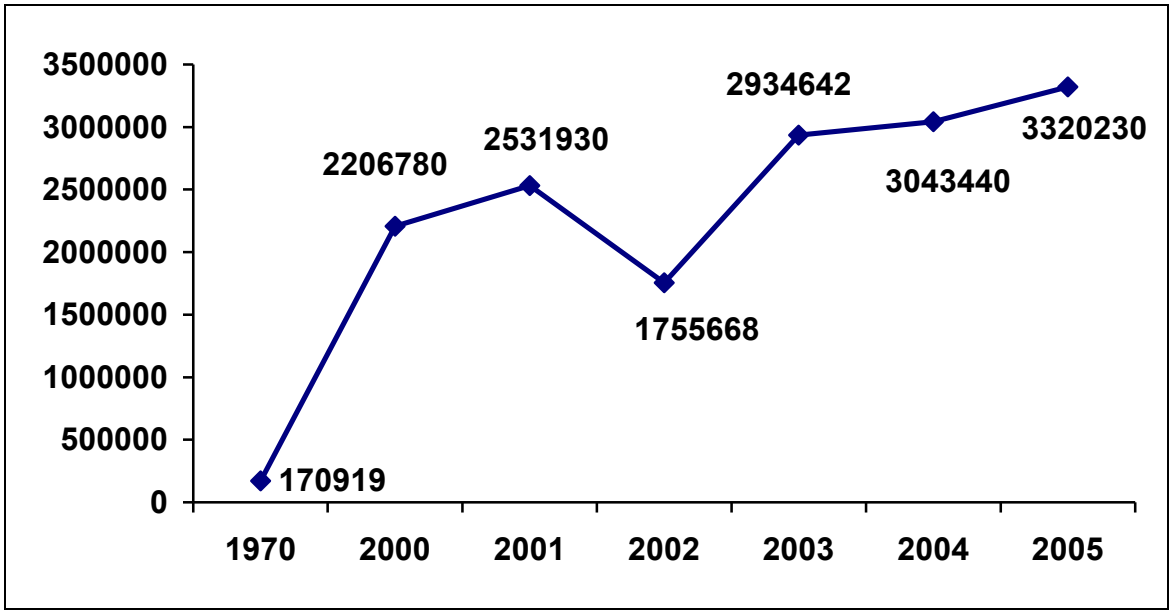


Fig. (26): Numbers of emergency services provided in Syria over 1970- 2005

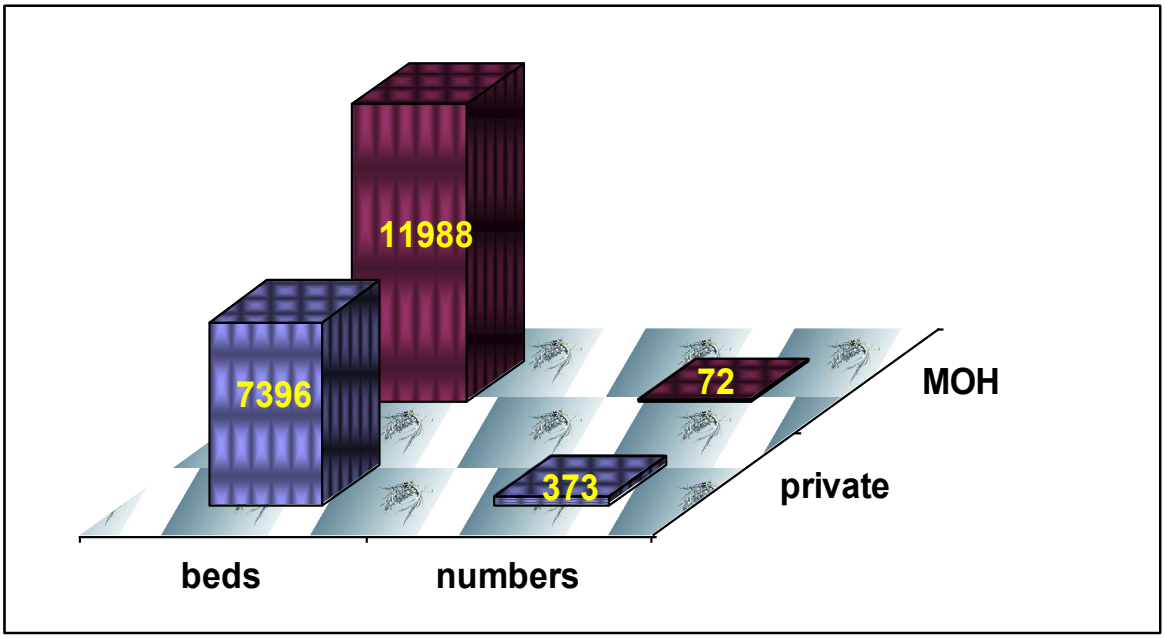


Fig. (27): Comparison between hospitals in the (MOH) and the private sector regarding their numbers and beds in Syria in 2005

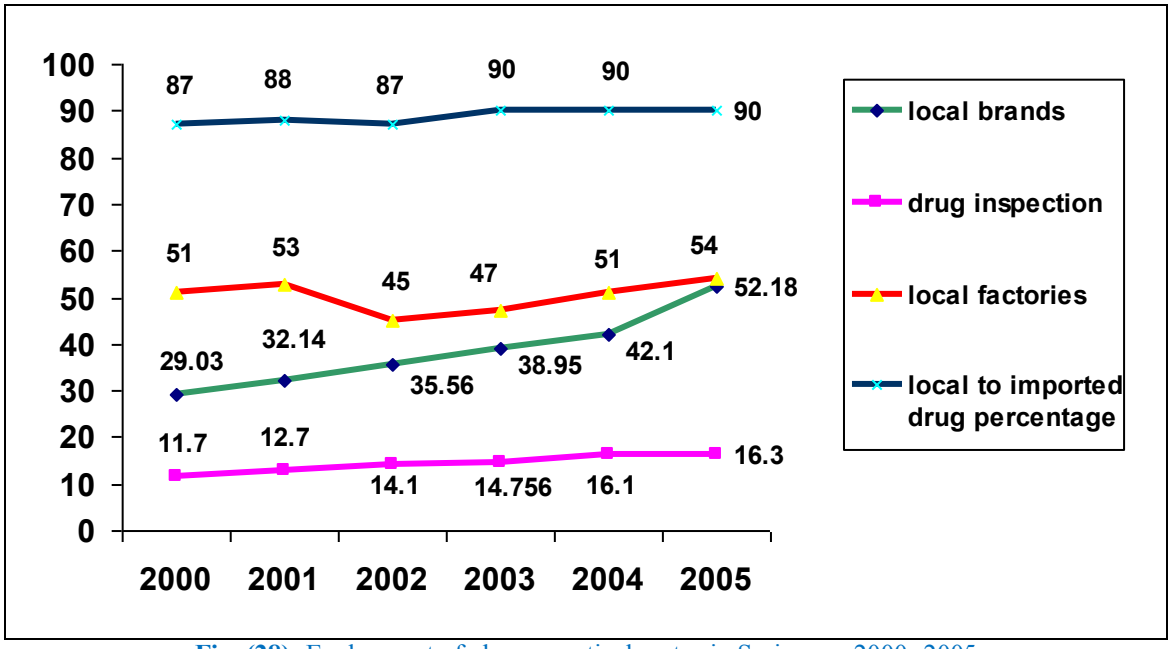


Fig. (28): Evolvement of pharmaceutical sector in Syria over 2000- 2005
(local brands= 100, imported brands= 1000)

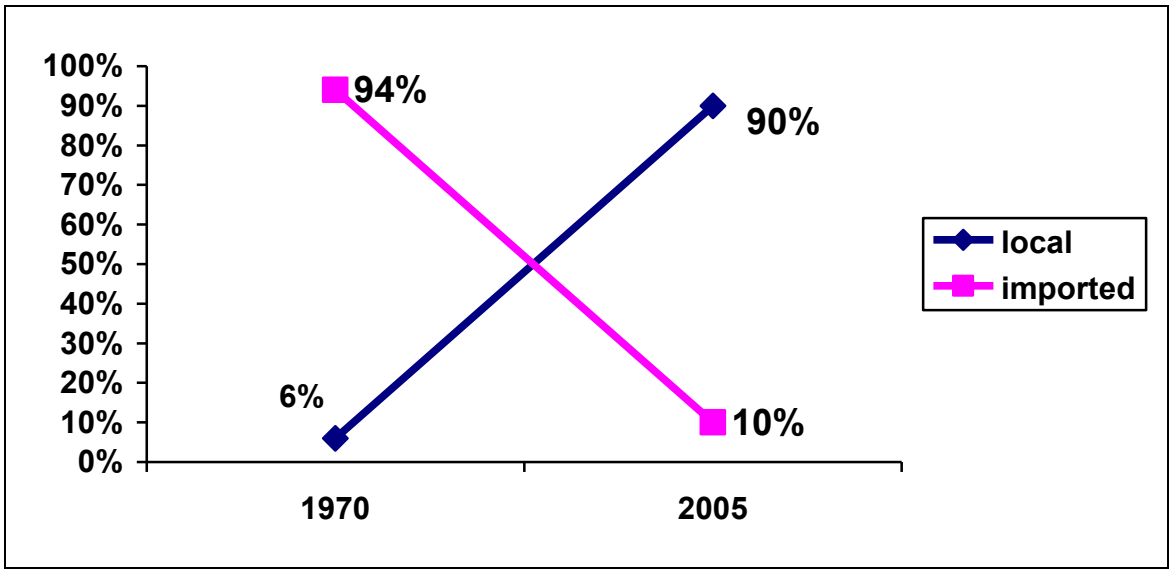


Fig. (29): Rate between local and imported drugs in Syria over 1970- 2005

Finance indicators of health sector:

- Per capita gross national product (hundred dollars) and per capita overall and governmental expenditures on health in Syria in 2005, Fig. (30).
- Health expenditures percentages in Syria in 2005, Fig. (31).
- Evolvement of the (MOH) budget (in thousands Syrian pounds) in Syria over 1992- 2005, Fig. (32).

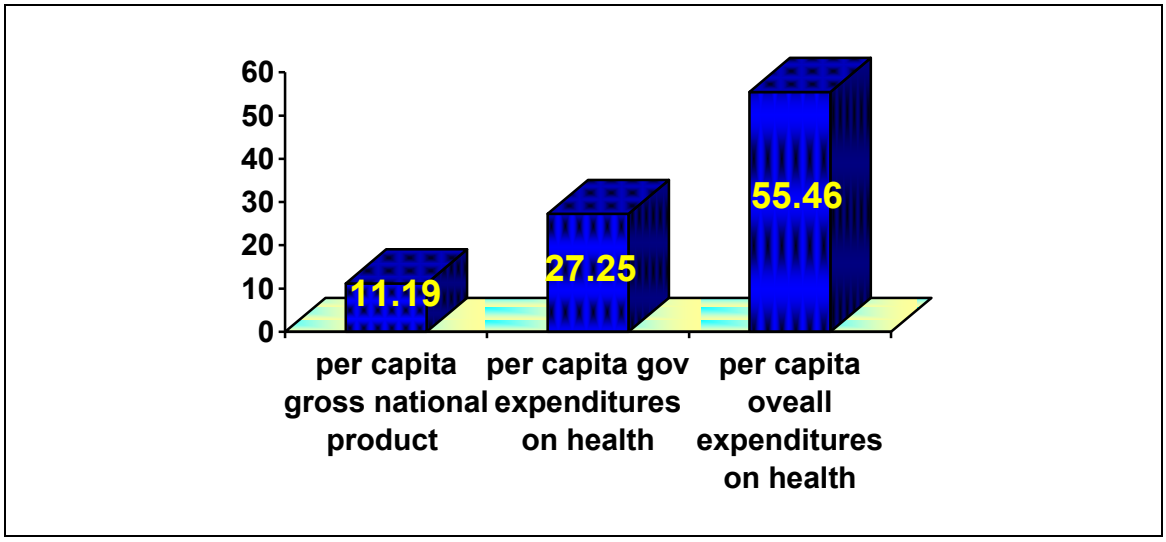


Fig. (30): Per capita gross national product (hundred dollars) and per capita overall and governmental expenditures on health in Syria in 2005

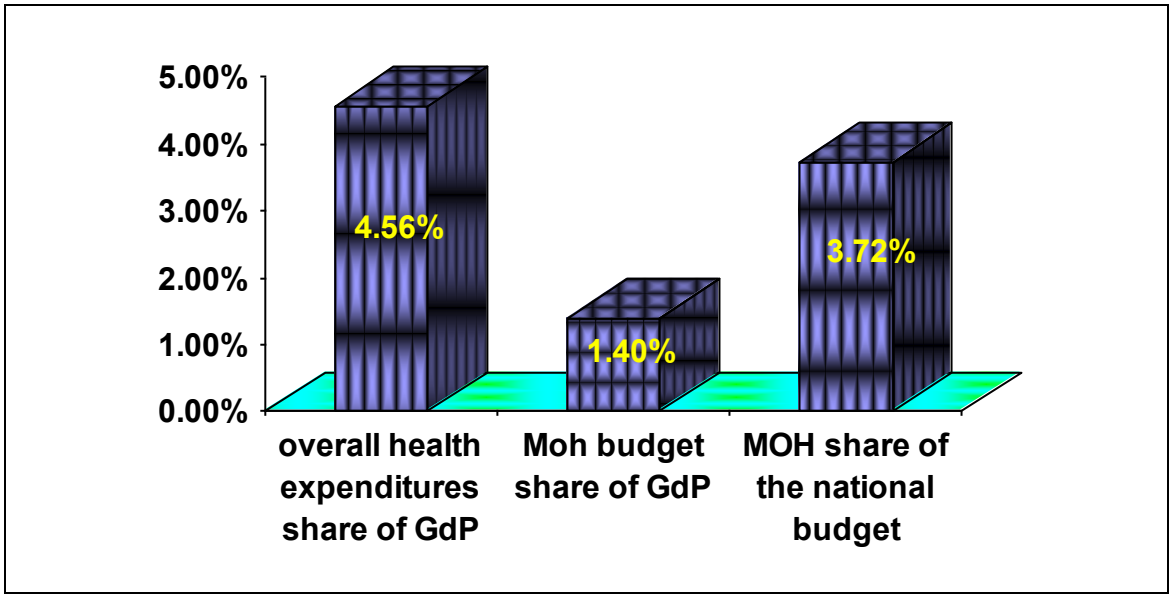


Fig. (31): Health expenditures percentages in Syria in 2005

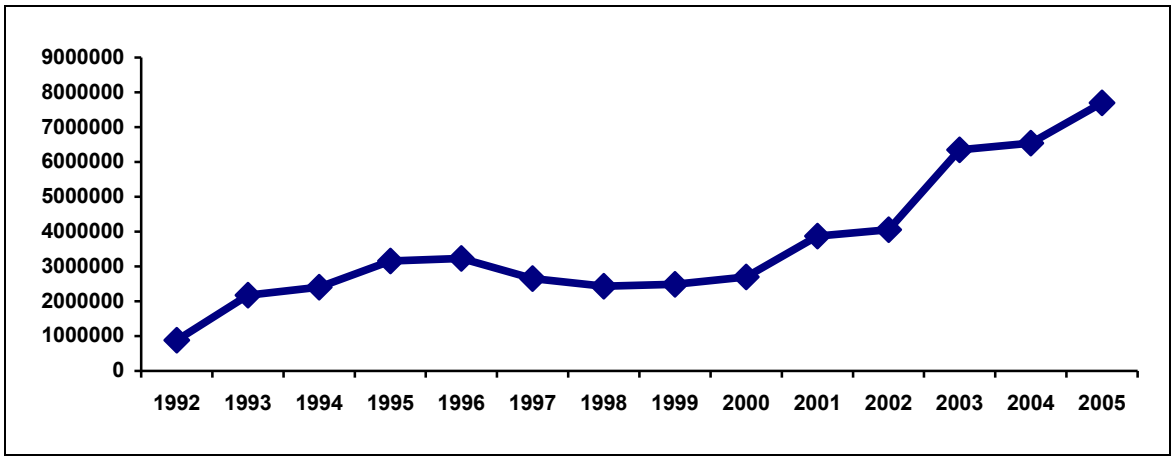


Fig. (32): Evolvement of the (MOH) budget (in thousands Syrian pounds) in Syria over 1992- 2005

The previous graphs show that private hospitals outnumber public hospitals, but on the other hand, the later have larger size and more beds. Therefore, public hospitals provide the biggest share of various health services and at the same time bear the biggest burden; hence there is need for further development to enable them to handle emergencies in case they happen.

The analysis of causes of death occurring in Syria in 2005 proved that the first cause is cardiovascular diseases (49 %), and respiratory diseases came third (5.6 %). It is well known that patients affected with these two types of diseases are most vulnerable to the impact of climate change. This issue should be taken into account when planning for dealing with health impacts of climate change.

Respiratory diseases were noticed to come on top of morbidity causes (11.5 %), gastrointestinal tract diseases follow (11.2 %), then cardiovascular diseases. All those diseases are prone to the effects of climate change.

The (MOH) budget percentage out of the national budget has increased from 3.26 % in 1992 to 4.22 % in 2005, yet this percentage needs further increases owing to the burden that health sector bears, especially the (MOH), under the influence of the multiple environmental problems. These problems tend to be aggravated following the environmental deterioration; meanwhile the (MOH) does not have the means to alleviate the environmental situation (since they are out of its jurisdiction). Nonetheless, the (MOH) allocates huge human, financial and logistic resources to deal with those problems' consequences.

Adding the potential health consequences of the climate change to what was previously explained gives an approximate view of the pressure put on the (MOH) and health sector.

4. Vector born diseases[iii,iv,v,vi,vii,viii]

4.1. Malaria

Malaria is one of the oldest diseases that humanity has suffered from. It is a parasitic disease, which is transmitted from infected to healthy people through some types of mosquitoes that spend the first period of their life cycle in fresh water.

Syria survived the Second World War but the health situation was deteriorated with malaria affecting about 5 % of the population.

Malaria control efforts started in 1949 on limited scale. The (DDT; dichlorodiphenyltrichloroethane) resistance emerged in 1969 leading to trigger the alarm once again. The World Health Organization (WHO) classified borderline areas with Iraq and Turkey as high-risk areas. Fig. (33) shows the chronicle progression of malaria along with potential predisposing factors.

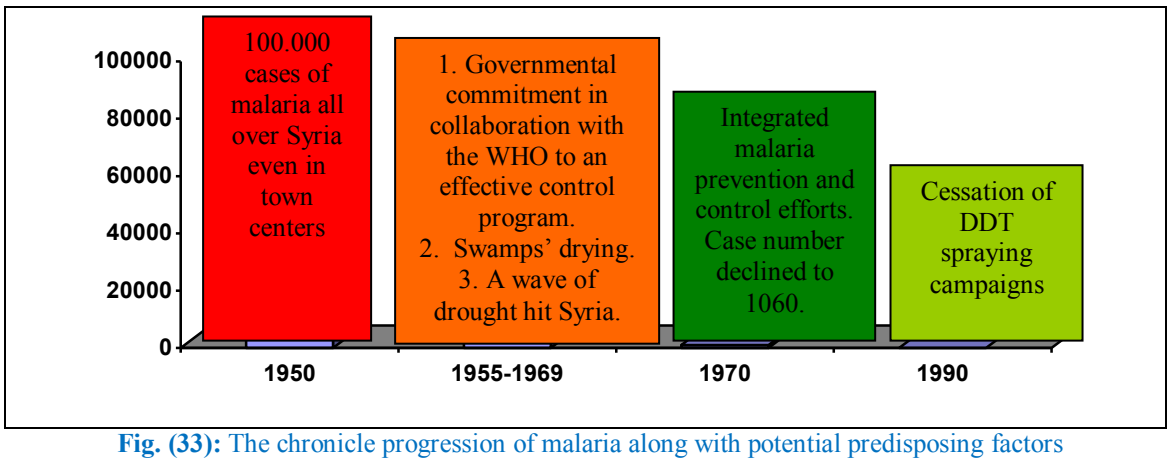


Fig. (33): The chronicle progression of malaria along with potential predisposing factors

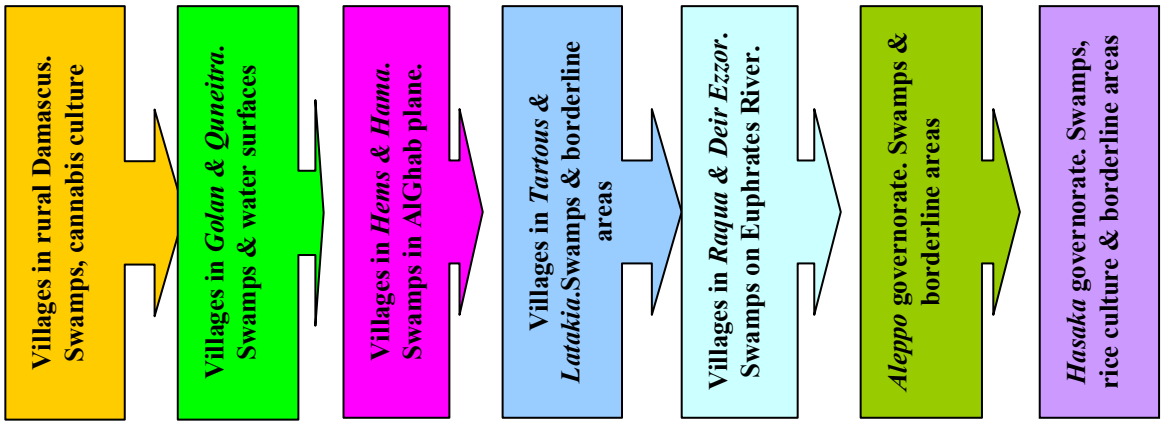


Fig. (34): Malaria spatial progression along with potential predisposing factors

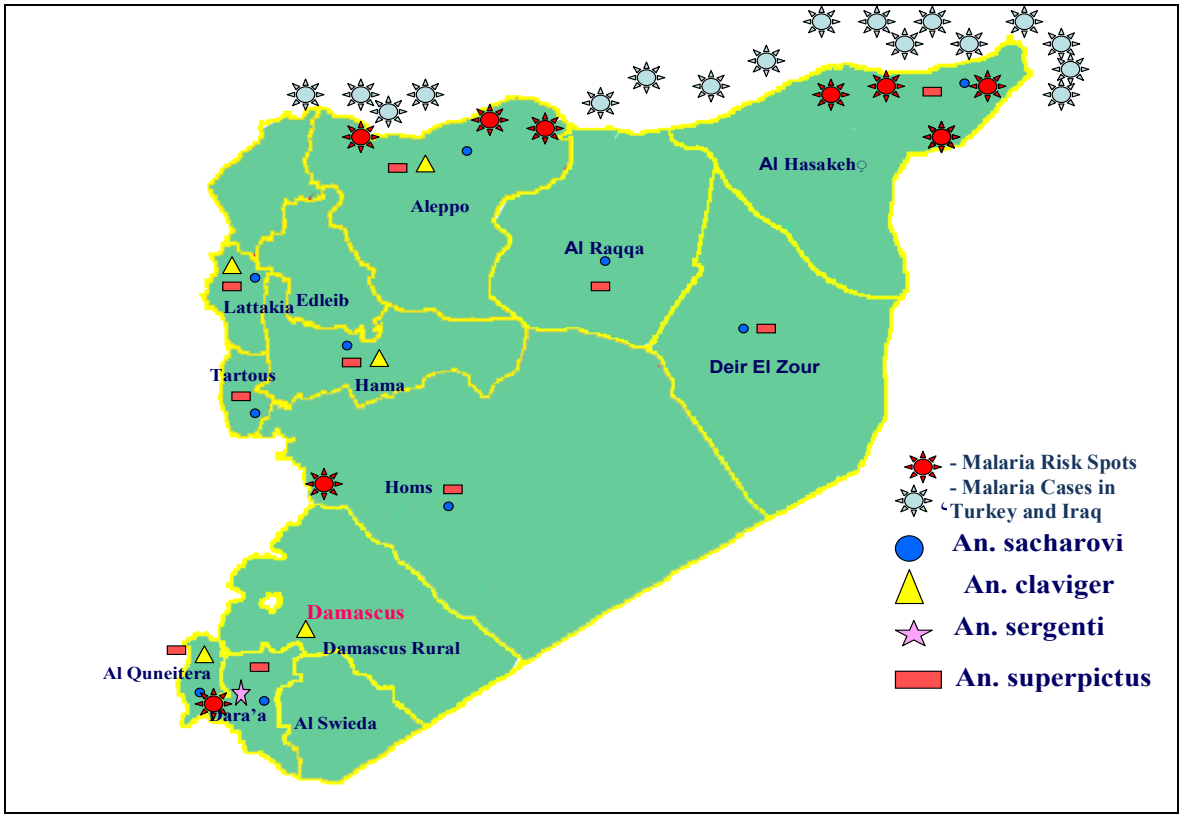


Fig. (35): The map of mosquitoes and malaria distribution in Syria in 2003

Climate change and relevant environmental and climatic factors affecting carrier mosquitoes of malaria:

1. Swamps and water surfaces.
2. Around average temperatures.
3. Humidity.
4. Medium precipitation is most convenient for mosquito breeding.
5. Wind speed of 20-35 Km/ h transports mosquitoes far away from breeding areas.

Risk factors in borderline areas with Iraq and Turkey:

1. Abundance of cases on the opposite site of borders.
2. Small rivers turn into swamps by summer season favoring mosquito multiplication.
3. Draining water out of rivers leads to the declining of water level hence the formation of swamps.

4. Cultivating cotton and rice gives a start for temporary swamps.
5. Human migration across borders and internal human displacement along with local tradition of out sleeping during summer are among factors.

***Causes of malaria prevalence retraction**:*

1. Implementing a very effective integrated control program supported by government commitment. A department for malaria control and prevention was set up. It was supported with special budget, staff, and independent mechanisms including implementing pesticide activities using chemical pesticides supported by the (WHO) Affected patients were treated soon enough and fast enough to assure their cure before the next infective season.
2. The consecutive drought seasons that Syria has suffered since the nineteen sixties contributed to reducing the number of malaria cases.
3. Environmental sanitation represented by drying swamps and prohibiting some types of cultivation activities played an important role.

***Recommendations to deal with risk factors**:*

The study of risk factors necessitates the following actions:

1. Giving special importance to performing lab tests on coming passenger from neighboring countries- especially Iraq and Turkey- in order to initiate active surveillance of affected people and offer them the treatment they need.
2. Continuous surveillance and control of mosquito vectors especially in borderline areas.
3. Reconsidering the rice and cotton cultivation and finding ways to avoid temporary swamps and mosquito multiplication.
4. Adopting the option of bio-prevention strategy instead of pesticide spraying to avoid surface water contamination.
5. Improving personal protective behaviors.

WHO is in its way to declare Syria free of local malaria in two-year time after performing needed insect surveys and applying malaria freedom standards by the end of 2009 (Fig. 36 and 37). Nevertheless, the possibility of malaria reemerging should be kept in mind especially with the existence of predisposing factors including the possibility of floods or dam breakdown in southern Turkey because of climate change leading to swamps' formation.

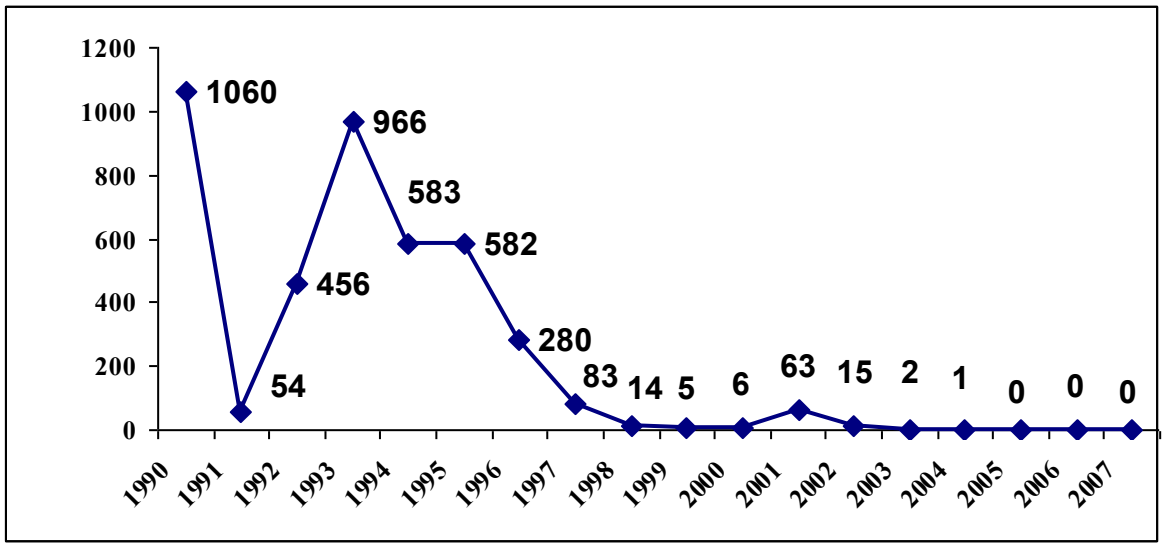


Fig. (36): Local malaria cases in Syria over 1990-2007

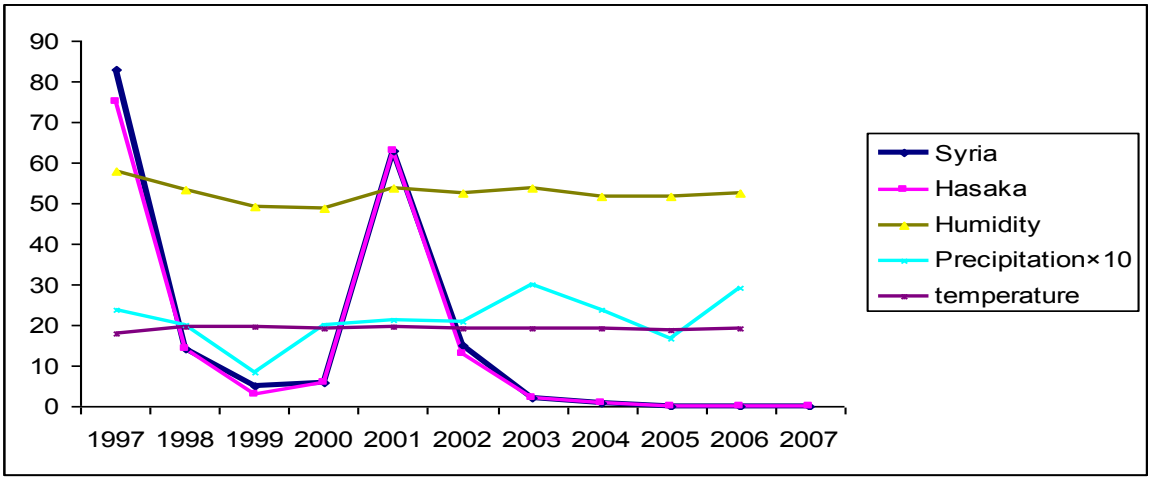


Fig. (37): Relation between climate factors and malaria cases in Syria and *Hasaka* governorate (1997- 2007)

4.2. Leishmaniasis

Leishmaniasis has been endemic in Syria for long time. The British physician, Bocock, diagnosed many leishmaniasis cases in the nineteenth century. The *Russel* brothers described the clinical features of cutaneous leishmaniasis (so-called Aleppo boil) in their book "History of Natural Medicine".

There are two types of leishmaniasis: cutaneous and visceral. Fig. (38) shows spatial distribution of various clinical types of leishmaniasis in Syria in 2003.

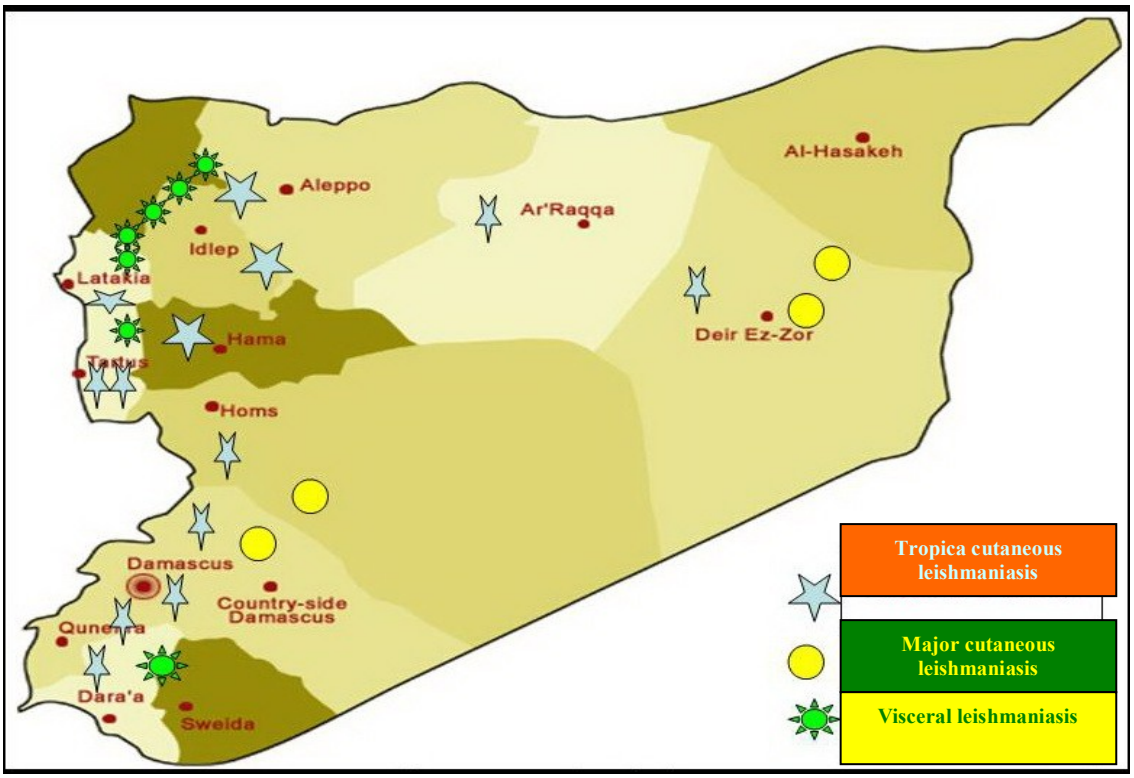


Fig. (38): Spatial distribution of various clinical types of leishmaniasis in Syria in 2003

Cutaneous leishmaniasis cases were restricted to Aleppo city, its suburbs and sporadic areas in Euphrates valley in 1960. Then they spread to almost every governorate in Syria owing to the following reasons:

1. Human migration.
2. Urban expansion.
3. Agrarian activities.
4. The suitable climate and environment supporting the vectors and reservoirs of the infecting agent (dark damp places with moderate temperatures, organic debris, human and animal degraded materials, and construction activity wastes).
5. Deteriorated public health conditions and hygiene especially in slums and illegal constructed buildings because of the extreme difficulty encountered in supplying health services and facilities.
6. The recent increase in leishmaniasis prevalence during the last two decades was attributed to the cessation of pesticide spray campaigns leading to proliferation of *phlebotomus* (sand fly).

The progression of cutaneous leishmaniasis prevalence in Syria can be seen in Fig. (39).

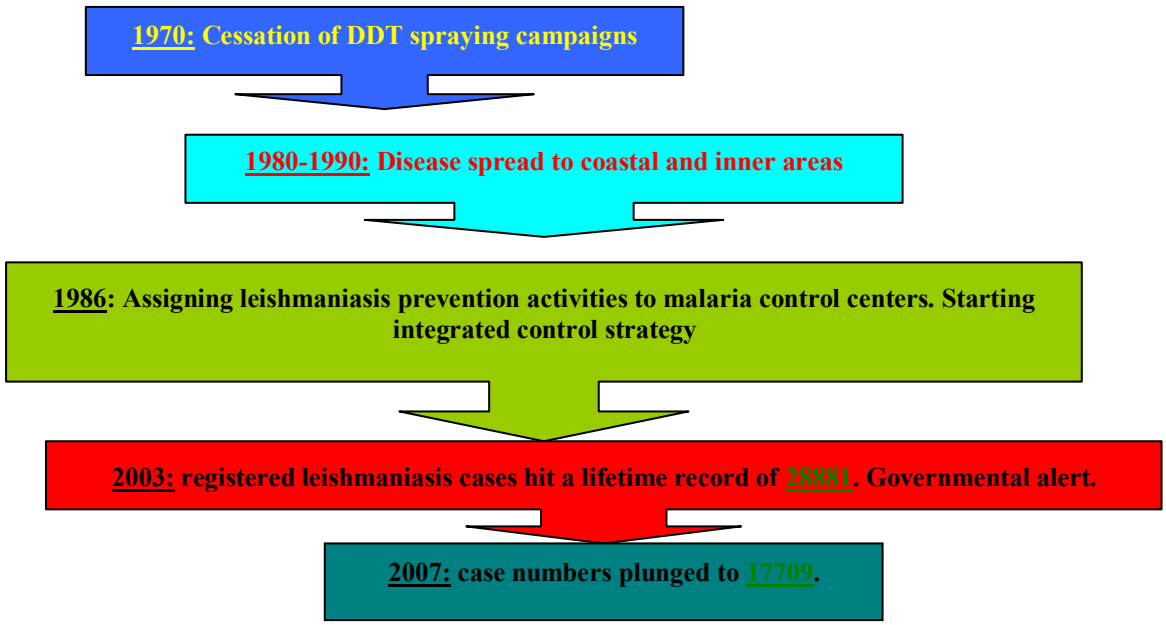


Fig (39): Progression of *cutaneous leishmaniasis* prevalence in Syria

Progression of leishmaniasis distribution in Syria in 1990-2007 can be seen in Fig. (40):

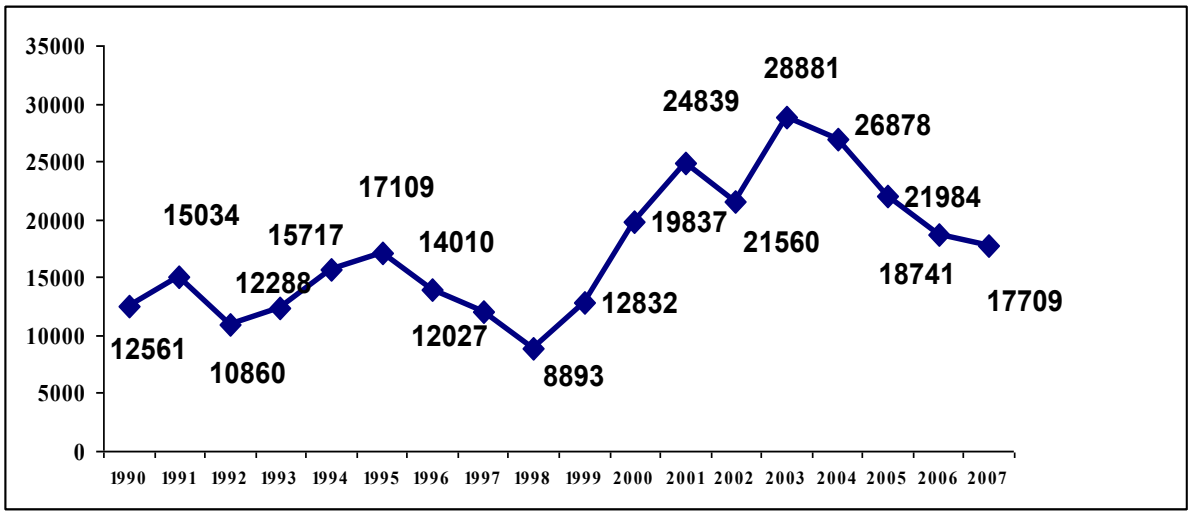


Fig. (40): The progression of *leishmaniasis* distribution in Syria over 1990-2007

Clinical manifestation of cutaneous leishmaniasis:
Cutaneous leishmaniasis has 3 types:

1. **Tropical (tropica.) cutaneous leishmaniasis**: represents 80- 90 % of allover cases in Syria. The infection is transmitted from patients to healthy people through the bite of infected female sand fly during the night usually (from sunset until dawn). The favorite season is summer after the rise in temperature, i.e. from early April until the end of October. Aleppo governorate represents the oldest focus of the disease; it accounts for half of the allover number of cases in Syria. The disease distribution involves the following governorates: *Hama, Idleb, Latakia, Tartous, Hims, Deir Ezzor, Raqa, Daraa*, and some towns in rural Damascus, Fig. (11). There are ten subspecies of the vector, sand fly, in Syria. The geographical and environmental factors influencing the vector are:
   - Altitude above sea level: many studies demonstrated that altitude affects the morphology of individual subspecies. It ranges from 50 m in coastal areas to 1500 m in rural Damascus.
   - Humidity and precipitation: some subspecies prefer humid environment therefore they exist in coastal areas.
   - Temperatures and insect population: the longer the period with moderate temperature the longer the seasonal availability period. The relative humidity of (58- 64 %) i.e. dry like weather supports the seasonal availability as well.

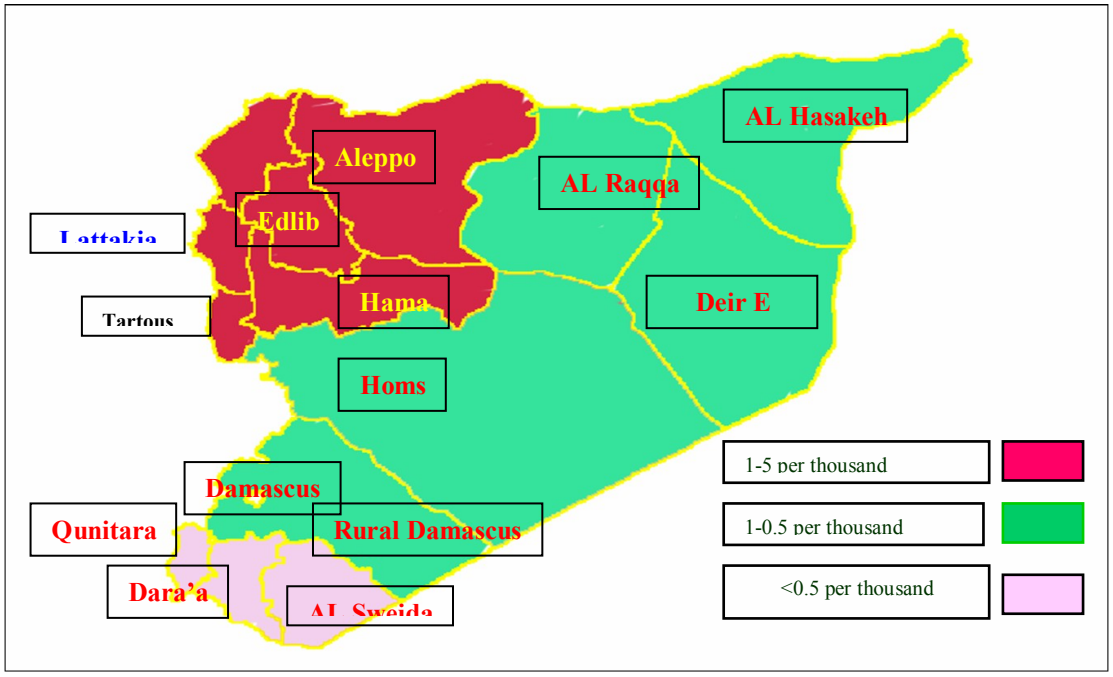


Fig. (41): Spatial *leishmaniasis* prevalence rate in Syria

While Aleppo is still the leading governorate nationally and regionally regarding leishmaniasis since it is a difficult to control old focus, there is a trend in other governorates for having more cases. *Latakia* outnumbers Aleppo regarding leishmaniasis cases. The underlying reason was the drought and warmth during winter in 1998-1999 and 1999-2000. That led to continuous disease transmission owing to persistent activity of *phlebotomus*. The comparison between the disease prevalence in Syria, *Aleppo, and Latakia* shows a constant positive relation between the first two, Fig. (42).

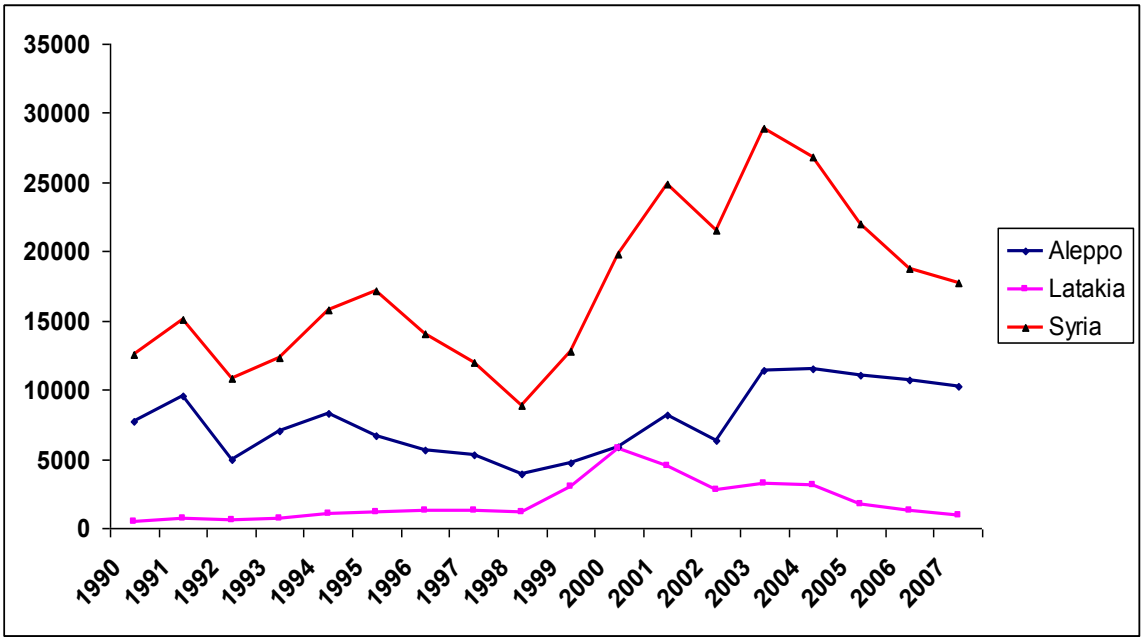


Fig. (42): *Leishmaniasis* prevalence in Syria, *Aleppo*, and *Latakia* 1990- 2007.

2. **Major cutaneous leishmaniasis:** this type accounts for about 10- 15 % of all leishmaniasis cases in Syria. The infection is transmitted from infected animals (desert rodents) to healthy human through the bite of infected female insects. It affects inhabitants of semi arid areas in *rural Damascus (Dumayr and South Kalamon towns), Hims (Palmyra and Quaryetein), Deir Ezzor (Abu Kamal and Sawar), and Hasaka (Shadadi and Fadagmi)*. The insect seasonal availability occurs in mid July and mid September. The weather conditions influence this availability since relatively dry hot weather (temperature; 18-28 C°, humidity; 58-64) is most suitable for the insect life cycle.

   The factors affecting the infection with cutaneous leishmaniasis of animal origin include:

   - Relatively hot dry weather favoring the seasonal availability.
   - Availability of "Anabasis Articulata" plant that represents the food for rodents (disease reservoir).
   - Declining of camel breeding which led to abundance of "Anabasis Articulate".
   - Declining of owl population (rodent predator) owing to expansion of cultivation activities.
   - Intensified hawk hunting (selling hawks to Arab Gulf states).
   - Lack of efficiency in rodent control performed by agriculture extension units.

   The cases in *Dumayr* hit a periodical peak every 10 years. The increase in incidence rate during 2004- 2005 happened because of increased human activities (Fig. 43).

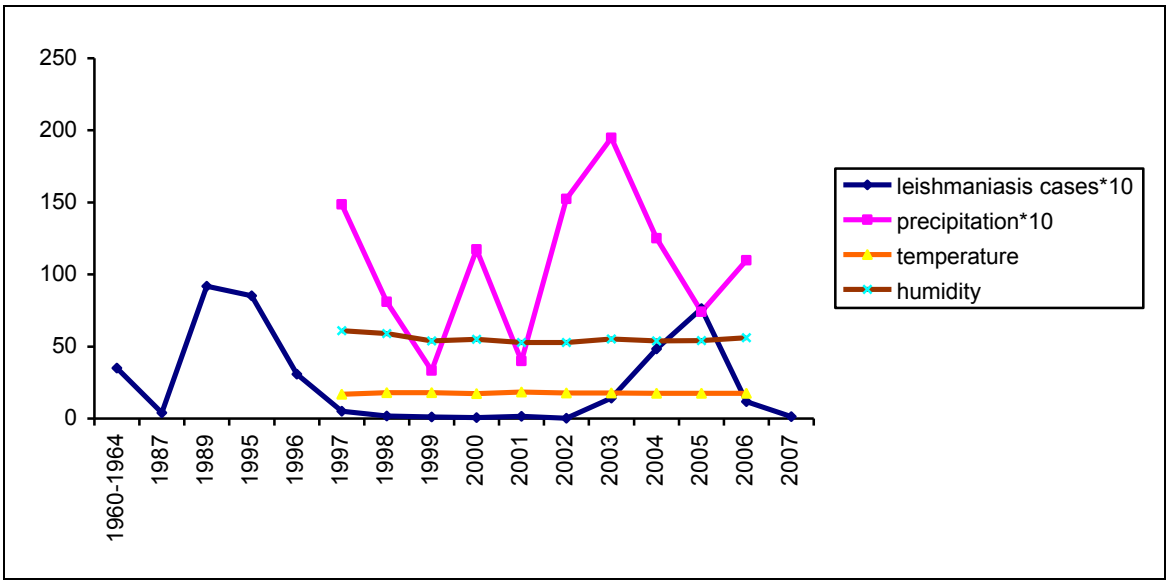


Fig. (43): *Cutaneous* (Major) *leishmaniasis* cases in *Dumayr* with temperature, humidity, and precipitation during 1960-2007

The highest incidence rate takes place in December three months after the vector (*Ph. Papatasi*) seasonal availability in September matching the wet cutaneous leishmaniasis incubation period. The weather in the area seems to suit the vector activity where relative humidity ranges from 58- 64 %, and temperature is around 25C° (18- 28C°) (Fig. 44).

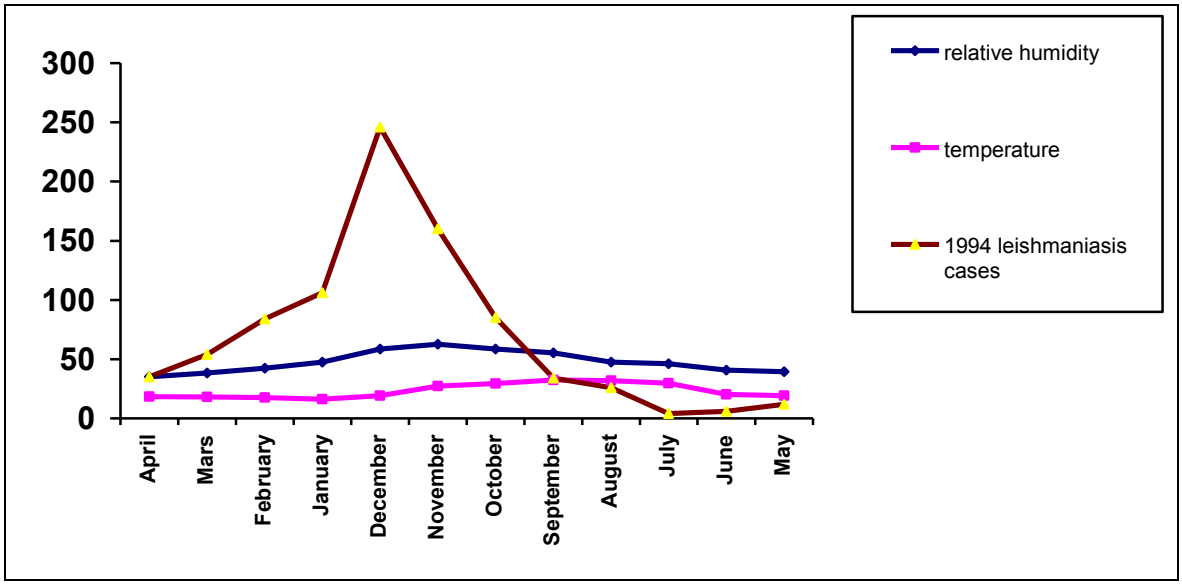


Fig. (44): Relation between *cutaneous leishmaniasis* and relative humidity and temperature in *Dumayr*, 1994

3. **Bilharzias (*shistosomiasis*):** It is a parasitic disease transmitted by a snail living in fresh water. It was introduced into Syria during the thirties of the nineteenth century through the French occupation military forces camping in *Hasaka* (*Kbour El Beed*). Six thousands cases of urinary *shistosomiasis* were recorded. Fig (45) illustrates the chronological progression of *shistosomiasis* in Syria.

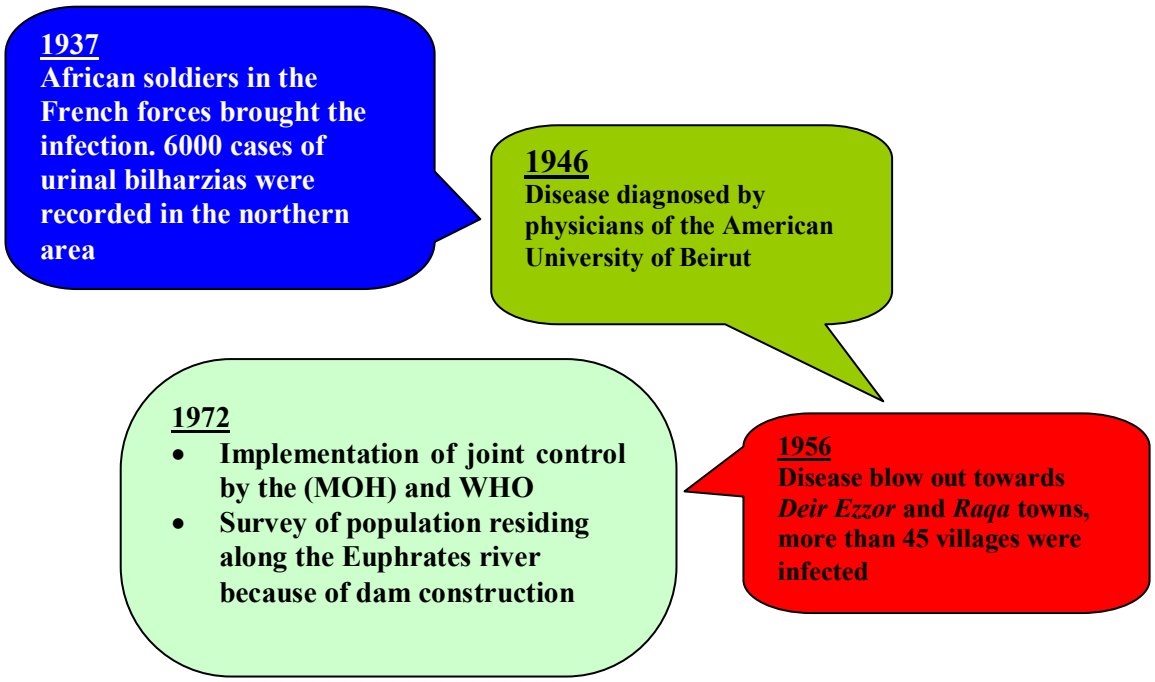


Fig. (45): The chronological progression of *shistosomiasis* in Syria

The relation between the disease and the climate:

1. Snail activity increases with rising temperatures, which means shorter incubation period for the eggs.
2. Snails generally tolerate very well gradual drought.
3. There are strong ties between the disease and agrarian and irrigation activities.

The implementation of chemical pesticides with case surveillance and treatment had a big role in controlling the disease.

The disease prevalence has declined clearly since the beginning of the late nineties; it went from about 1000 cases to 5 cases only in 2005, and then to nil thereafter (Fig. 46). The (MOH) in coordination with WHO is heading towards declaring Syria free of the disease if no cases are recorded during the coming three years.

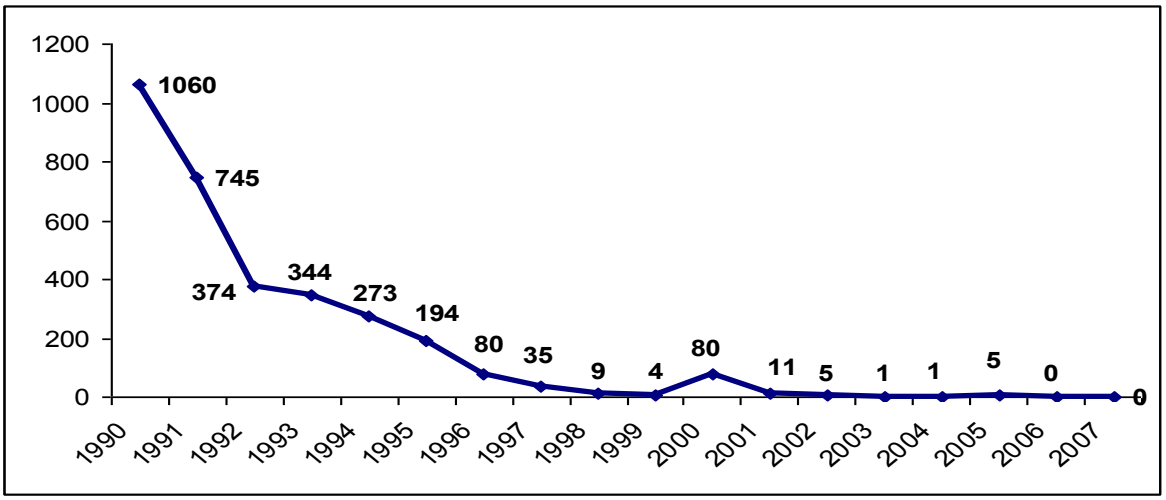


Fig. (46): *Shistosomiasis* cases in Syria in 1990-2007

Shistosomiasis belongs to the groups of diseases that are affected by environment and climate change (Fig. 47). Therefore, it is mandatory to keep alive surveillance and control under the need for agrarian projects and the possibility of taking water from the Euphrates

River to irrigate remote areas; which means creating opportunity for disease spreading towards new locations and becoming endemic.

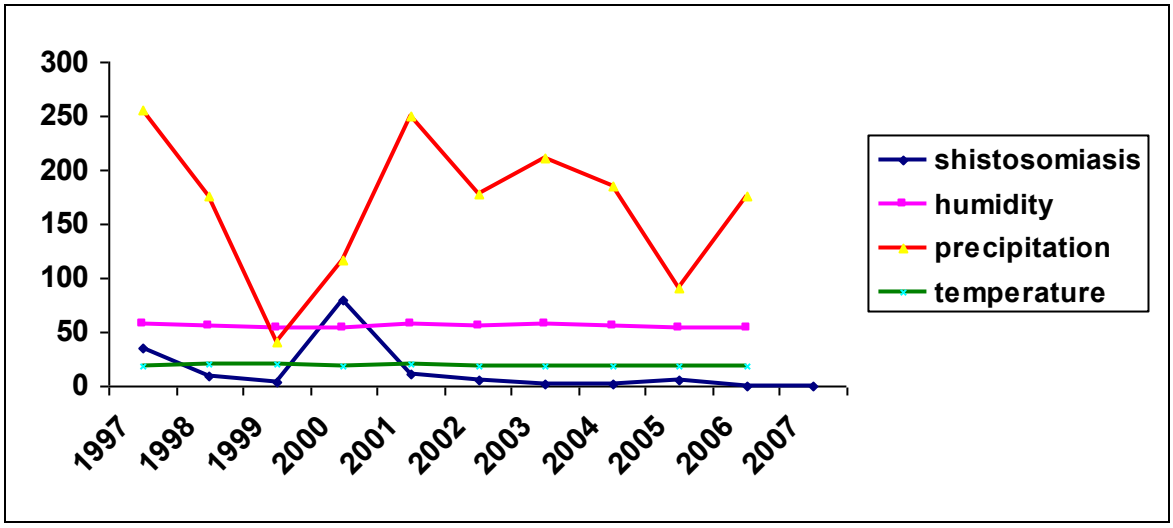


Fig. (47): Relation between *shistosomiasis* cases and temperature, humidity, and precipitation, 1997-2007

5. Agrarian sector and health[ix,x]

The statistical set "Time Series in Agrarian Sector, 1970- 2005" issued by the Central Bureau of Statistics (CBS), and the document called "2006 Annual Agrarian Statistical Set" issued by the directorate of planning and statistics in the Ministry of Agriculture and Agrarian Reform were reviewed thoroughly. The review revealed that agrarian sector while having close ties with the nutritional situation of Syrian population and being affected by the climate change has undergone tremendous development in every domain including vegetables, fruits, livestock and strategic crop production such as wheat.

Graph 35 illustrates wheat production (100.000 tons), beans (1000 tons), and percentage of agrarian sector share in the (GNP) comparing to other sectors (market price) in Syria during the period 1970- 2006.

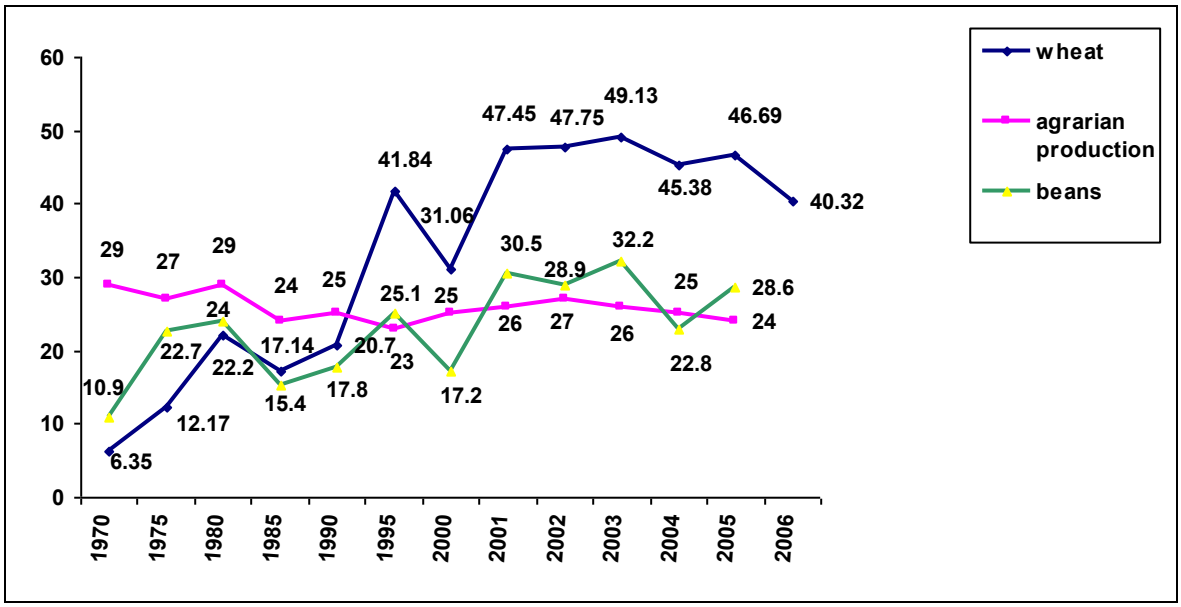


Fig. (48): Wheat production (100.000 tons), beans (1000 tons), and percentage of agrarian sector share in the GNP comparing to other sectors (market price) in Syria 1970-2006

Figure (49) shows vegetable and fruit production (100.000 tons) in Syria over 1970-2005.

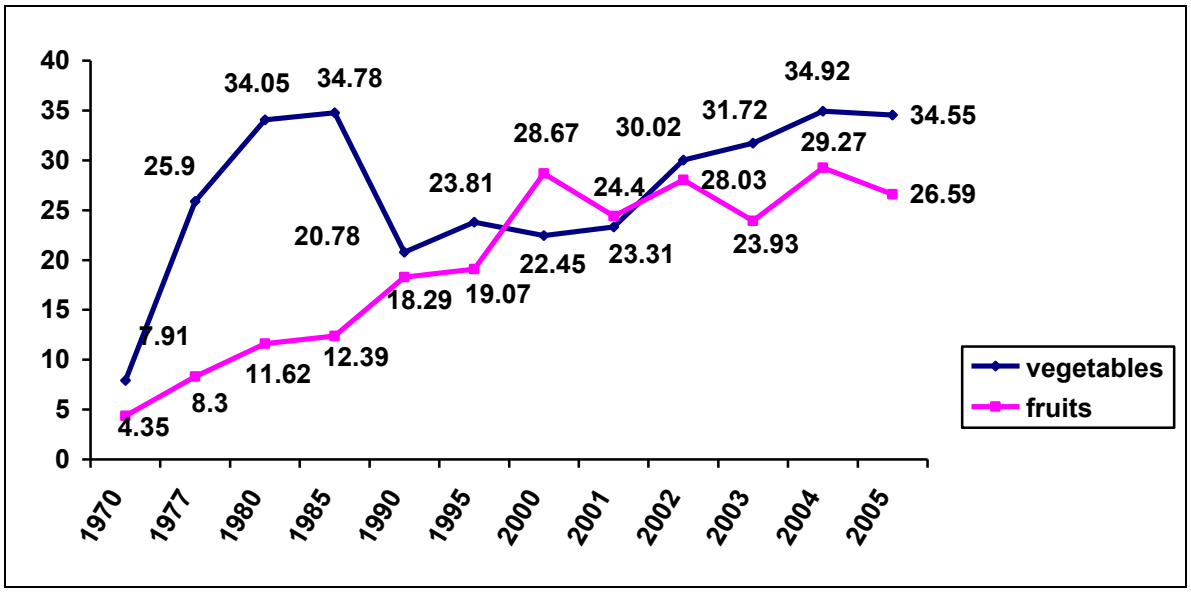


Fig. (49): Vegetable and fruit production (100.000 tons) in Syria over 1970-2005

Figure (50) shows milk (100.000tons), red meat (10.000 tons), poultry (10.000 tons), and fish (1000 tons) production in Syria over 1970- 2005.

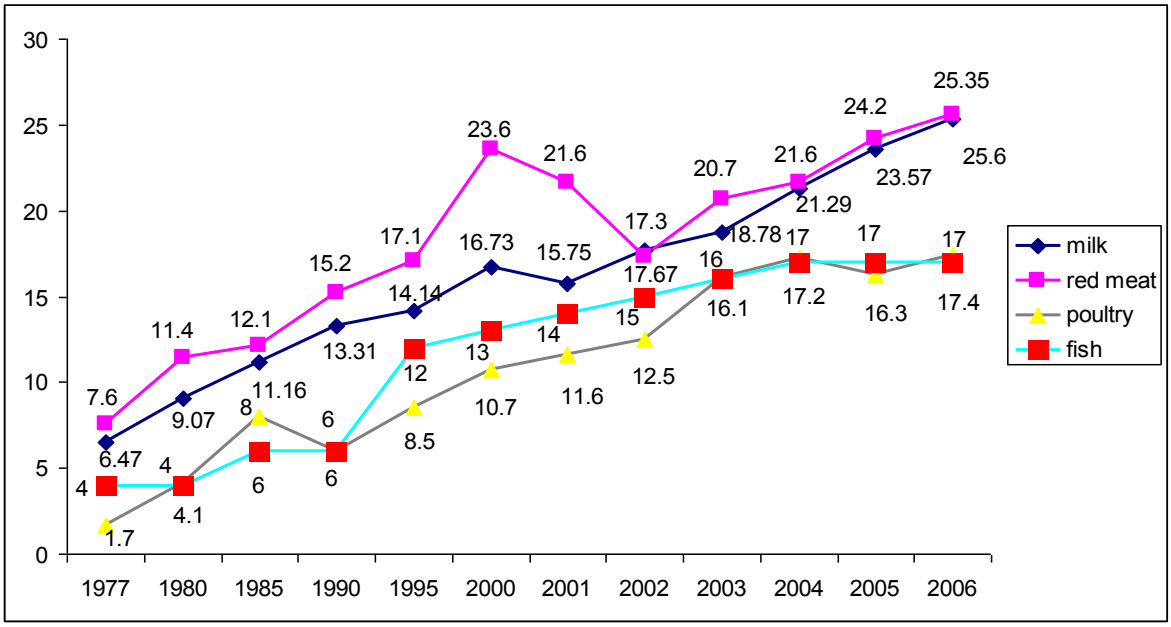


Fig. (50): Milk (100.000 tons), red meat (10.000 tons), poultry (10.000 tons), and fish (1000 tons) production in Syria over 1970- 2005

Since these productions constitute the main base for the nutritional status, their data were matched to the data extracted from studies conducted by the (MOH) and data taken from the CBS. The objective of the matching process was to link "under five" children nutritional status to the agrarian production quantities.

Digging deep into the reasons for the ongoing agrarian development revealed that their roots laid in the proper management and the use of modern practical and scientific techniques, and not the increased availability of resources. On the contrary, resources are getting scarce.

Taking a closer look to (Fig. 51) representing malnutrition indices in "under five" children, and (Fig. 52) representing crop production with short stature index in Syria between 1994 and 2006, shows a general trend towards declining nutritional status with different speeds. That gave rise to three important questions whose answers may have a connection, though complicated, with the potential health impacts of climate change through the agrarian impacts themselves.

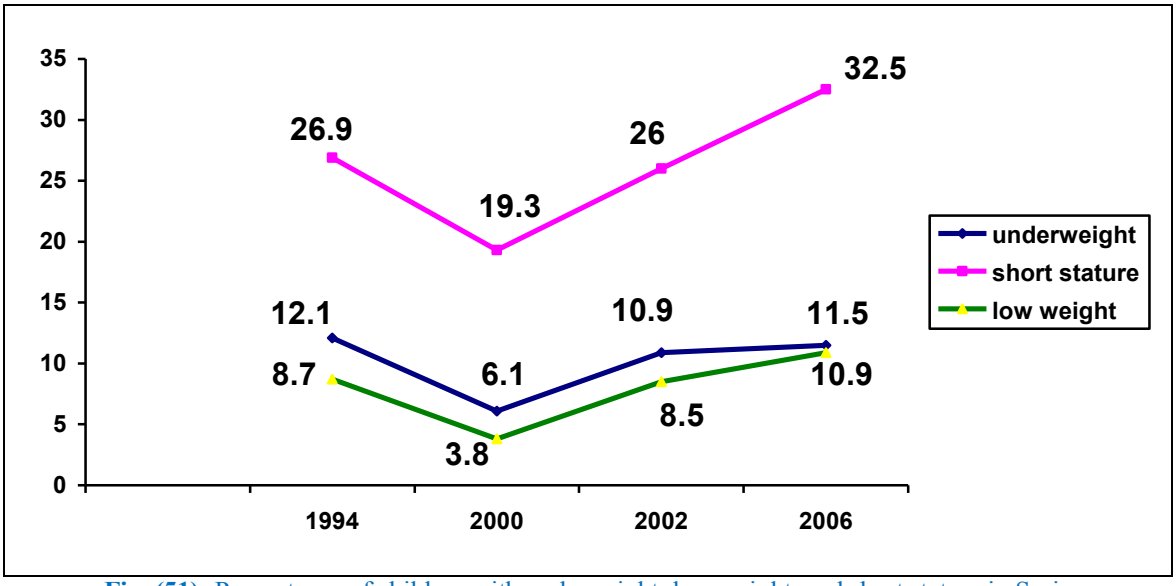


Fig. (51): Percentages of children with underweight, low weight, and short stature in Syria between 1994 and 2006xi,xii,xiii,xiv

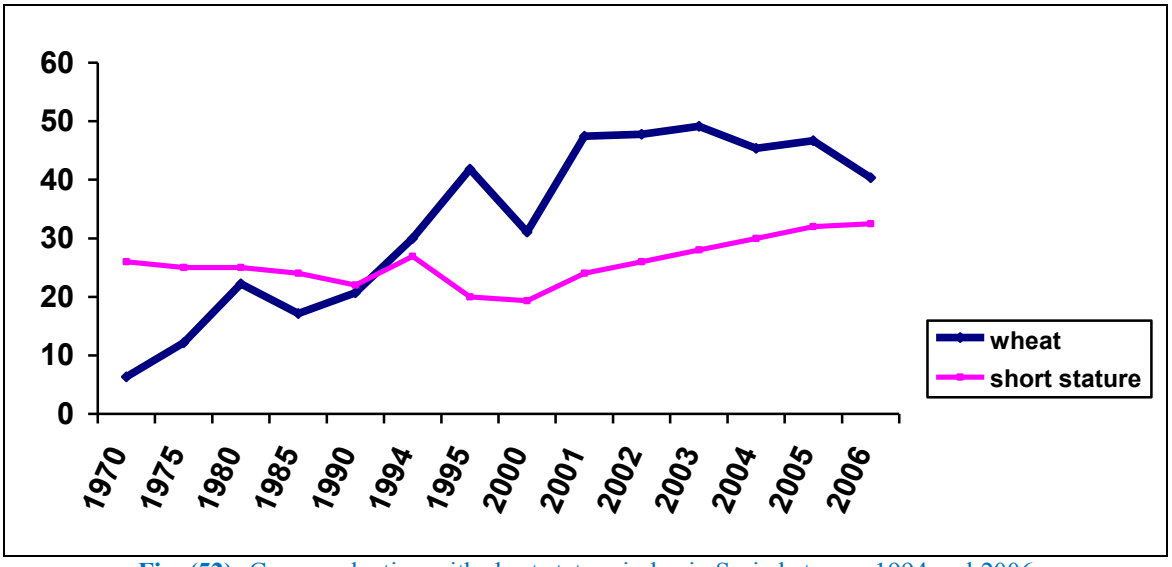


Fig. (52): Crop production with short stature index in Syria between 1994 and 2006

The first question: can the perceived agrarian development cope with the growing needs of an increasing population in current rate regarding the essential nutritional needs whether on the quality or the quantity side?

The second question: what is the practical and scientific ceiling that the agrarian production can reach depending on the current competent management of available resources without any real increase in these resources? Alternatively, do we have to anticipate the day when this production hits the roof leaving the country to face a very critical situation?

The third question: is related to the mainstream financial capacity of the population particularly youth and children (or their guardians). Taking into account that Syrian population are mainly youth, does this capacity cover the basic necessary nutritional needs?

We cannot rely on the declining nutritional indices only to create a comprehensive perception of nutritional status and availability of foods. Nutrition depends on various factors; some are personal or environmental, others are related to the socio-economical status. Thus, malnutrition cannot be considered merely the result of essential food shortage, though it is a very important factor. It is very necessary to go deeply into the investigation of malnutrition causes in an accurate and scientific way that uses long time series to uncover the exact links that enable designing suitable intervention programs.

6. Water and health

Sufficient and safe water is considered most essential for good health. Any reduction of water quantity and/ or quality sets the alarm, especially regarding water born diseases. The changes in individual share of water[xv] and related diseases were analyzed for Syria and some governorate.

Fig 13 illustrates the negative trend renewable water per capita m^3/ year from 1950 until expected 2025.

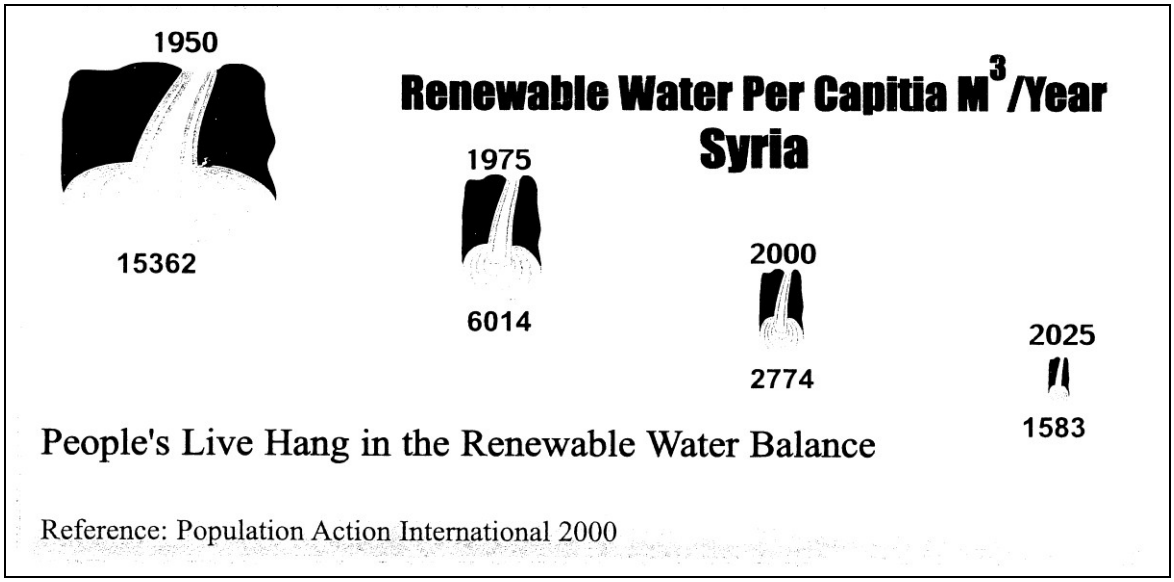


Fig. (53): the negative trend in renewable water per capita m3/year from 1950 until expected 2025xvi

Syria: Figure 54 illustrates the frequencies of some water related diseases[xvii] matched to per capita water quantity in Syria over 2000- 2007. A general trend towards increased diarrhea incidence was noticed as the water quantity plunges. No such trend was noticed in case of viral hepatitis or typhoid fever.

***Ouneytra* Governorate[xviii]:** A trend towards increased number of diarrhea cases was noticed as the per capita drinking water declines. There was a slight similar trend in typhoid and viral hepatitis cases as well (Fig. 55); it is well known that the later two diseases are well related to water and food pollution with sewage since the infecting agents are well defined and the human body is the only known reservoir for them. They manifest mainly as outbreaks resulting from mixing drinking water with sewage following some extreme weather events such as floods. What makes outcomes worse is the impotent wastewater drainage system allowing polluted water to access drinking water.

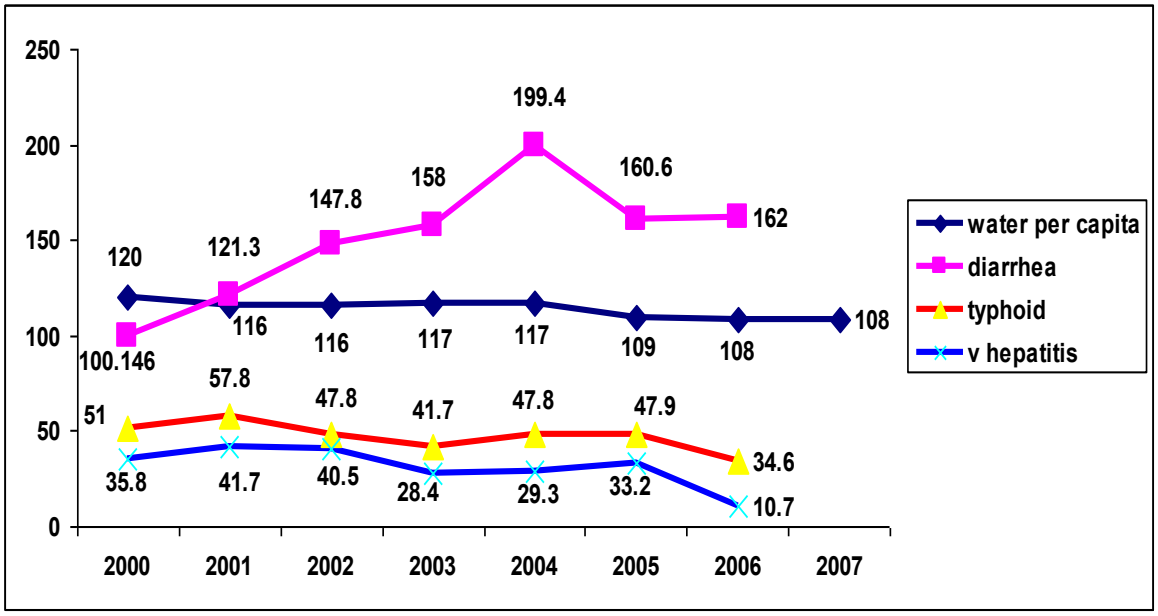


Fig. (54): The frequencies* of some water related diseases matched to per capita water quantity in Syria over 2000- 2007, *(Water quantity per capita= l/ day, diarrhea= 1000, typhoid= 100, v. hepatitis= 100)*

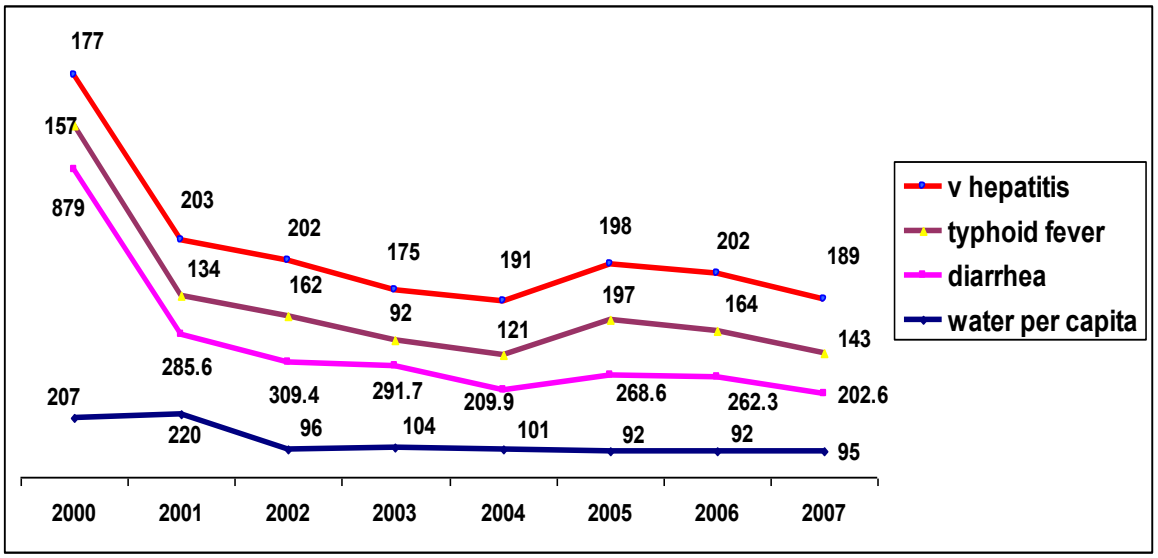


Fig. (55): The frequencies* of some water related diseases matched to per capita water quantity in Quneytra Gov. over 2000- 2007, *(Water quantity per capita= l/day, diarrhea= 1000, typhoid= 100, v. hepatitis= 100)*

Figure (56) illustrates percentages of diarrhea cases during July, August and September out of total annual cases in *Quneytra* Governorate (2000-2006).

When the per capita drinking water was reduced significantly in Quneytra Gov. in 2002, the diarrhea cases kept increasing during October and November, i.e. the months characterized by scarce drinking water quantities during years with low precipitation.

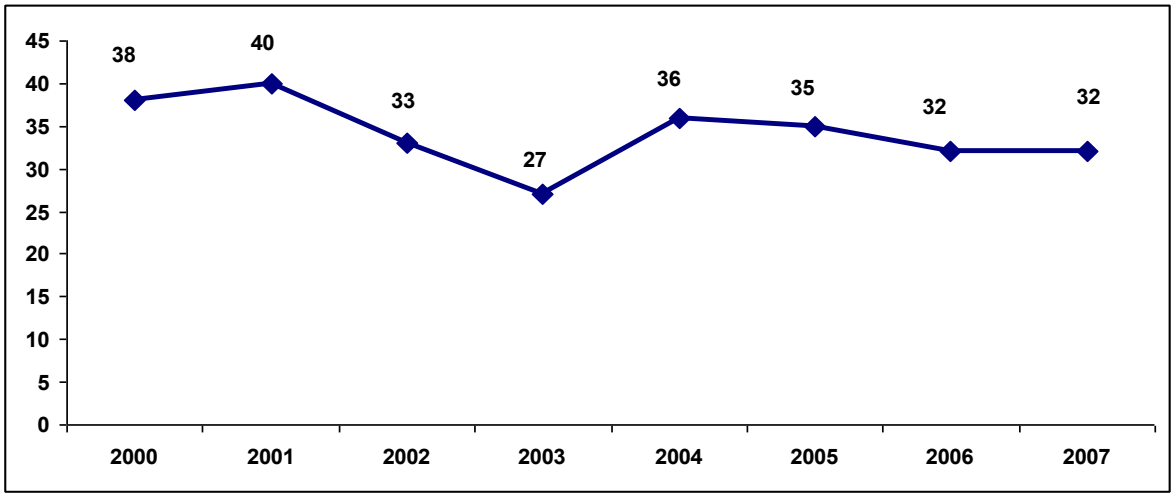


Fig. (56): Percentages of diarrhea cases during July, August and September out of total annual cases in *Quneytra* Gov. (2000-2006)

Rural Damascus Governorate[xix]: The highest diarrhea case numbers was recorded during 2005 (Fig. 57) compared with 2006 and 2007 despite the fact that 2005 had higher per capita drinking water. Having a closer look at the wastewater treatment plant coverage in the governorate revealed that there was none in 2005. Hence, the importance of interrelationship leading to the health impact of environmental factors becomes clear.
The same was noticed regarding typhoid fever in 2005. Meanwhile viral hepatitis A did not show this trend possibly because of its special features such as long-lasting immunity following infection and the significant number of subclinical cases (most of childhood cases).

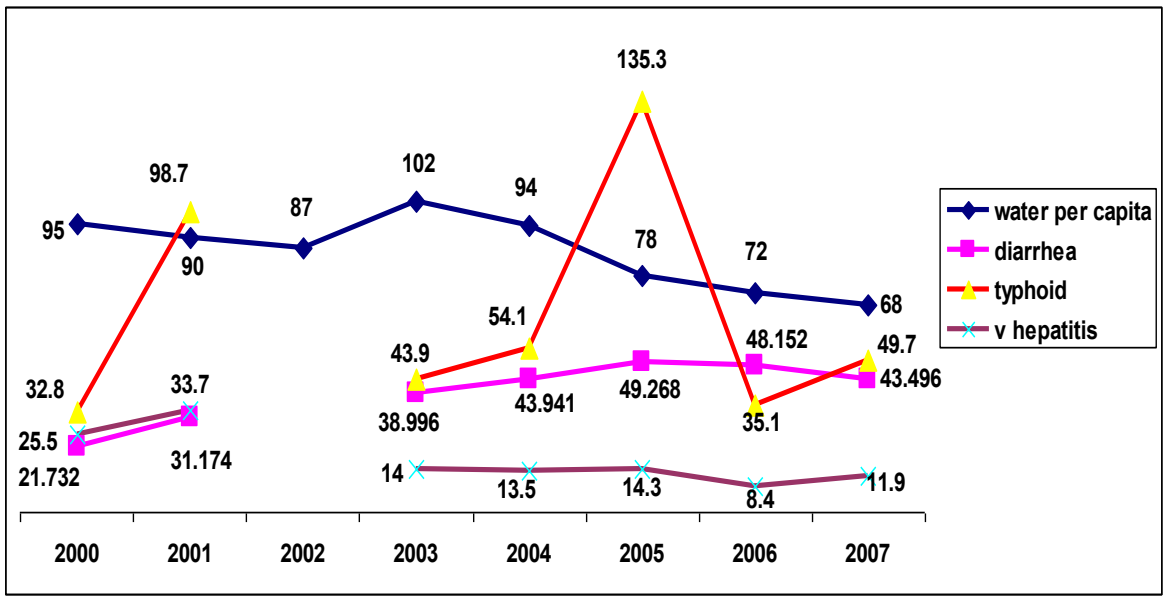


Fig. (57): The frequencies* of some water related diseases matched to per capita water quantity in Rural Damascus Gov. over 2000-2007, *(Water quantity per capita= l/ day, diarrhea= 1000, typhoid= 100, v. hepatitis= 100)*

Figure (58) illustrates percentages of diarrhea cases during July, August and September out of total annual cases in Rural Damascus Governorate (2000- 2006).

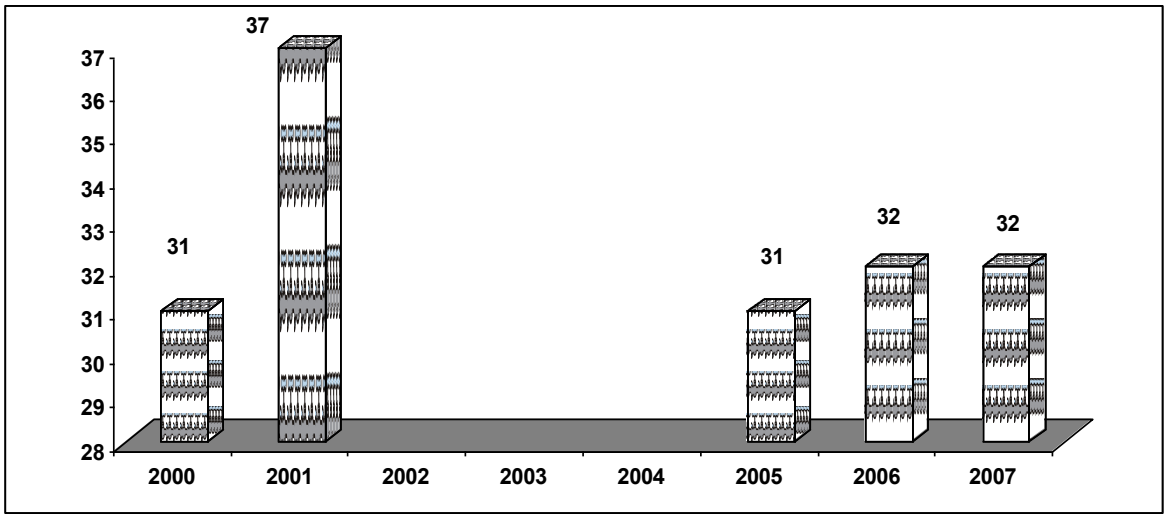


Fig. (58): Percentages of diarrhea cases during July, August and September out of total annual cases in Rural Damascus Gov. (2000-2006)

Damascus Governorate[xx]: There was no clear relationship between water per capita and water born diseases in Damascus, possibly because of the influence of some other factors such as availability of efficient wastewater drainage net and good environmental awareness and behaviors. Figure 59 illustrates the frequencies of some water related diseases matched to per capita water quantity in Damascus over 2000- 2007.

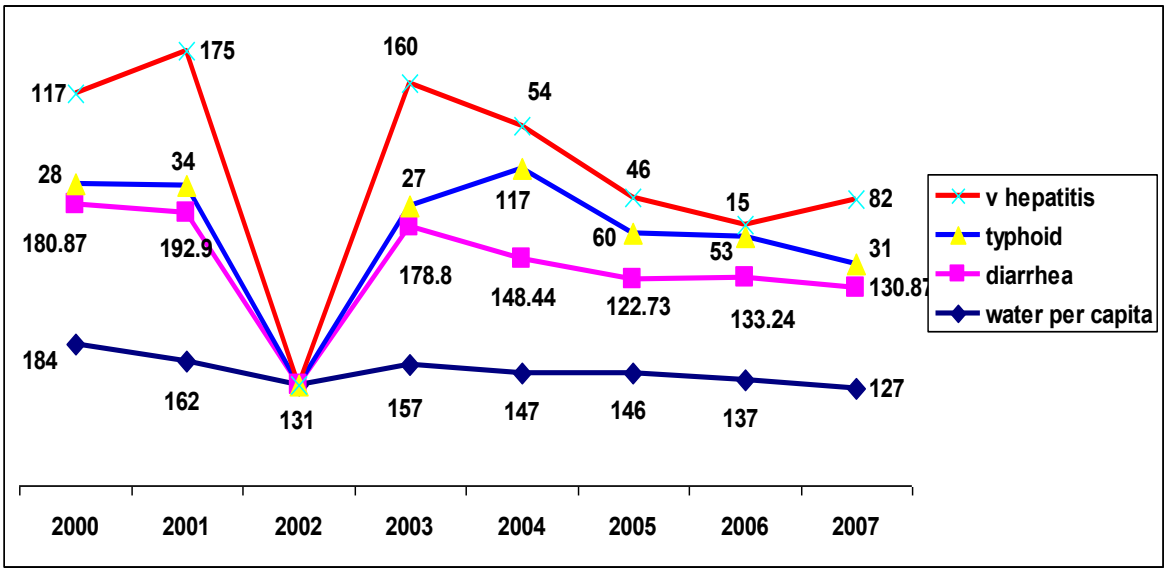


Fig. (59): Illustrates the frequencies* of some water related diseases matched to per capita water quantity in Damascus over 2000- 2007, *(Water quantity per capita= l/ day, diarrhea= 1000, typhoid= 100, v. hepatitis= 100)*

Figure 60 illustrates percentages of diarrhea cases during July, August and September out of total annual cases in Damascus Governorate (2000- 2006). It can be seen that the percentages ranged between 33- 40 %.

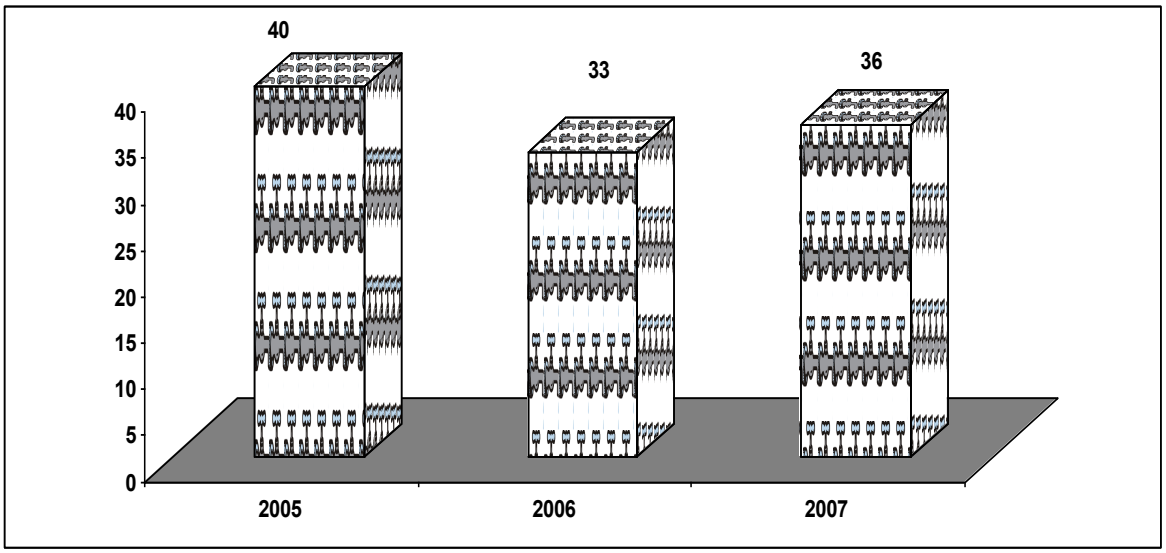


Fig. (60): Percentages of diarrhea cases during July, August and September out of total annual cases in Damascus Governorate (2000- 2006).

7. Weather Temperatures[xxi], Sand Storms[22], Hazy Weather[22], and their Health Impact

Moderate temperature and non-polluted air are very essential for good health. Any extremism in any of them would lead to more cardiovascular and respiratory problems.

7.1. Rising temperature and its health impact

Morbidity: There was a sharp rise in angina pectoris cases during hot months in Syria (Figure 61). This rise continued in fall season suggesting the possibility of linkage between the disease and hazy weather conditions prevailing in seasonal transitional weather. In addition, there was a rise in these cases accompanying the sharp raise of temperature in the following governorates: *Aleppo, Hasaka, Hims, Raqa,* and *Daraa*. There might be some other contributing weather factors such as hazy days in October affecting the deterioration of angina pectoris cases.

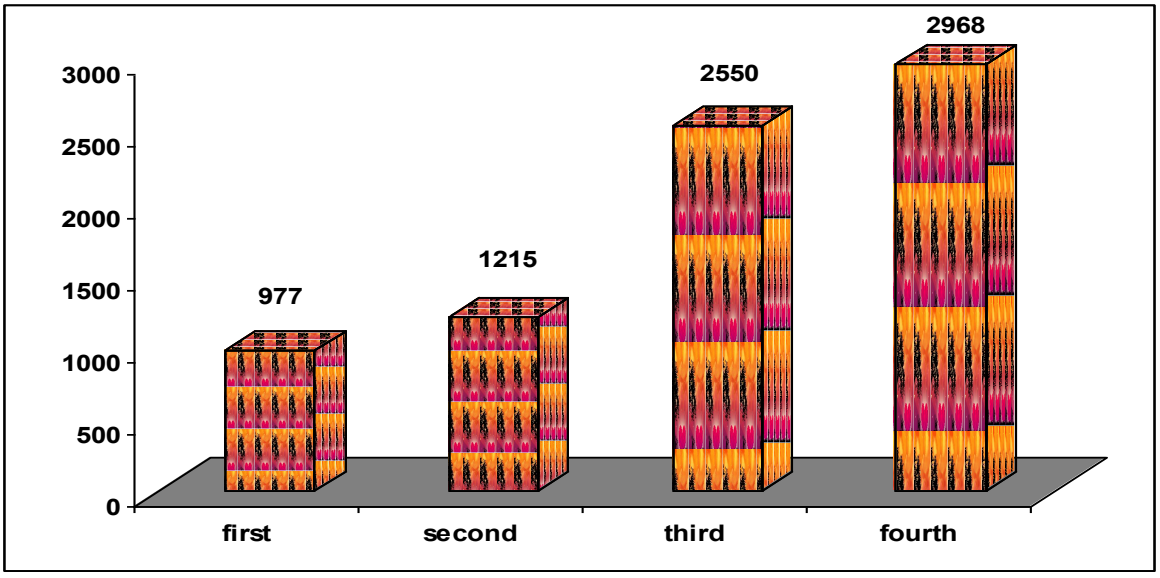


Fig. (61): Mean of angina pectoris case numbers18 in Syria over 2005- 2007- according to year quarters (MOH) records

The acute myocardial infarction cases were noticed to be increased during months with extreme temperature (up and down) as it is shown in Figure 62.

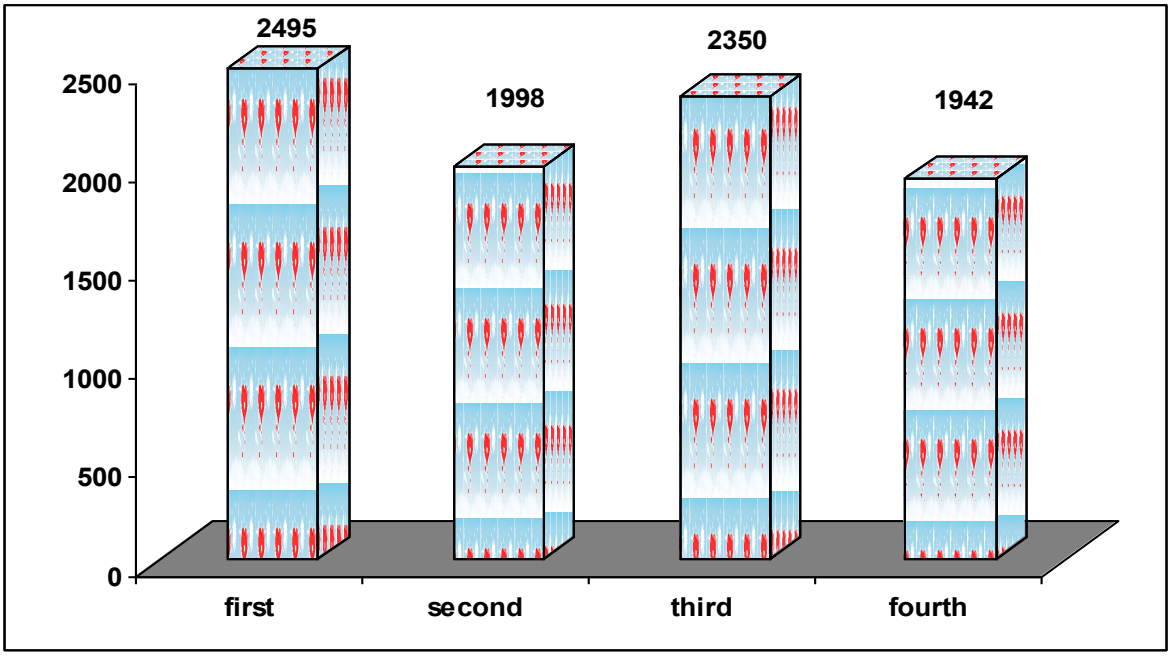


Fig. (62): Mean of acute myocardial infarction case numbers18 in Syria over 2005-2007 according to year quarters (MOH) records

As for asthma cases, two peaks were noticed (Fig. 63): the first and most prominent one occurred during winter cold months, and the second occurred during hot summer months. The focus of the first peak was located in the following governorate: *Tartous, Lattakia, Idleb, and Deir Ezzor* suggesting certain kind of link with humidity in coastal areas or with extreme freezing weather in inner areas (*Deir Ezzor*). The possibility of some other factors coexistence necessitates further deep observation and investigation.

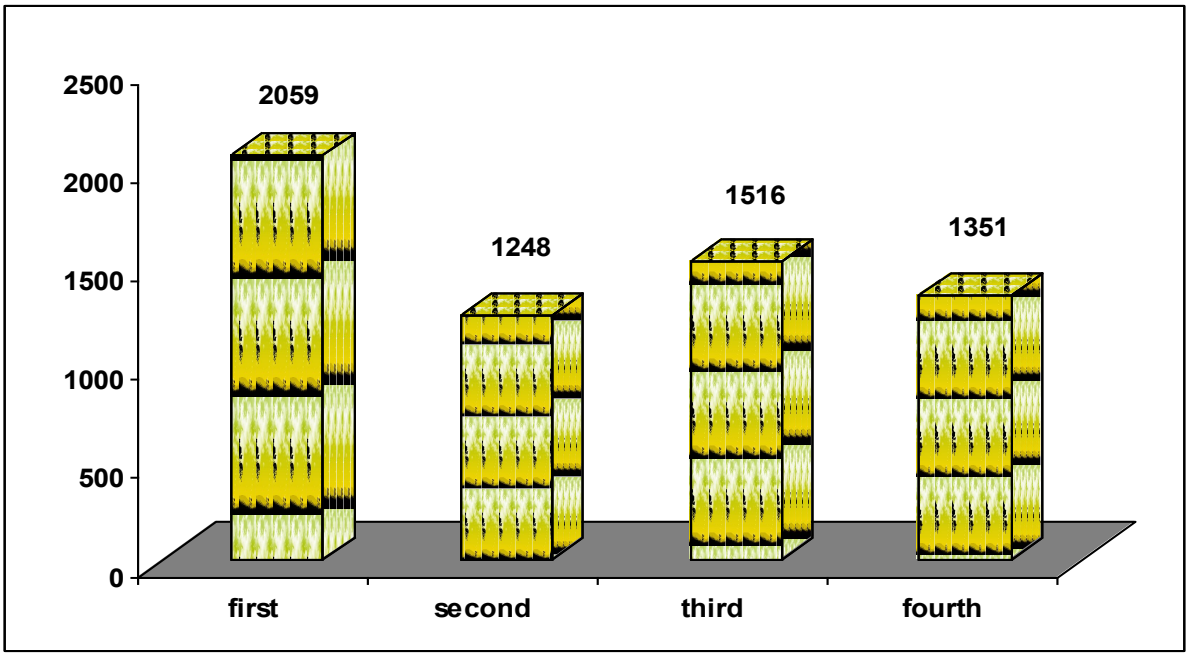


Fig. (63): Mean of asthma case numbers18 in Syria over 2005- 2007- according to year quarters (MOH) records

Damascus Governorate: The analysis of some climate related disease[δ] data in Damascus is summarized here.

It was noticed that the case number means of heart conditions recorded monthly in (MOH) health centers were almost stable over the period of 2000- 2007. The reason could be that the disease was brought under control, or that many patients prefer to seek service at the private sector (no data were available from this sector).

Meanwhile bronchial asthma cases have shown season fluctuation, as it may be expected, where the biggest numbers recorded during allergy months, i.e. March, April, and May.

Figure 64 illustrates means of asthma (unit= 10) and heart condition (unit= 100) cases recorded monthly in Damascus health centers over 2000- 2007.

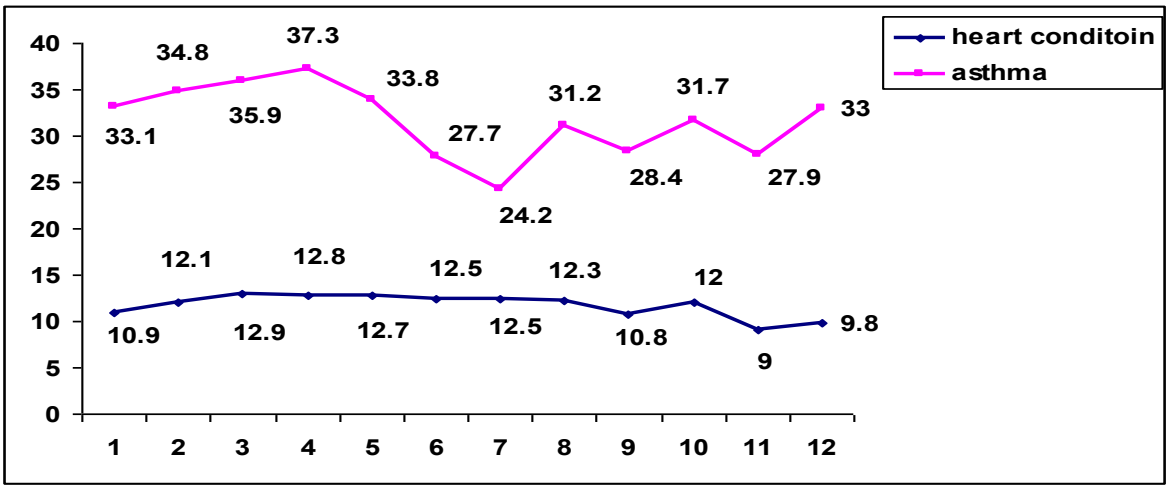


Fig. (64): Means of bronchial asthma (unit= 10) and heart condition (unit= 100) cases recorded monthly in Damascus health centers over 2000- 2007

No direct relationship was noticed between the number of days with high temperature (above general average of maximum temperature) and the case numbers of bronchial asthma (unit= 10) or heart conditions (unit= 100) registered in health centers during July in 2002- 2006 as it is shown in Fig. 65.

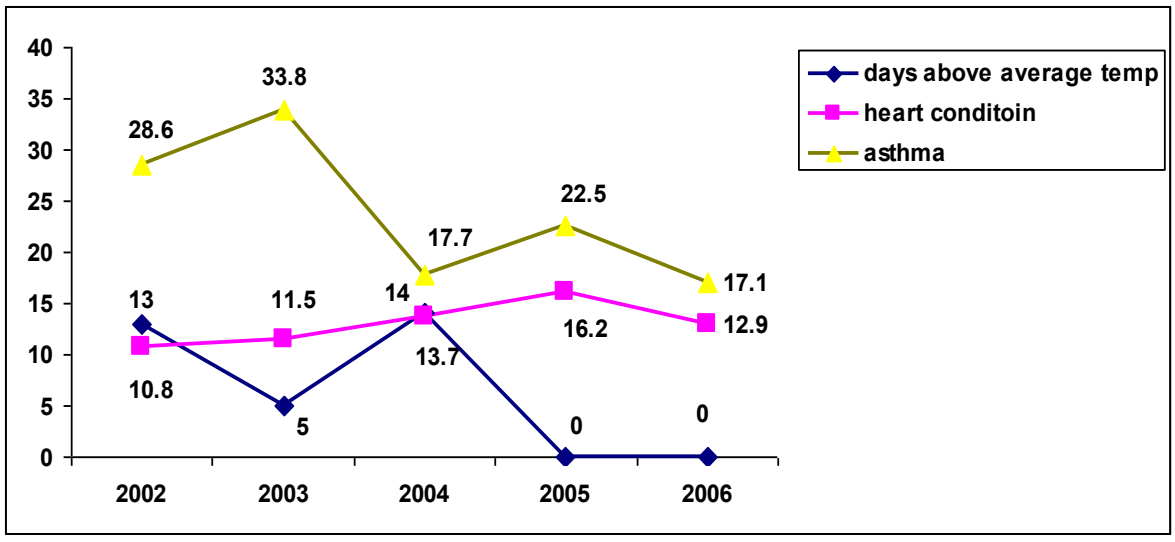


Fig. (65): The number of days with high temperature (above general average of maximum temperature) and the case numbers of bronchial asthma (unit= 10) or heart conditions (unit= 100) registered in health centers (unit= 100) during July in 2002- 2006

[δ] Health centers' statistics from reference number 21, hospital statistics from reference number 18.

A clear relationship was noticed between the number of days with high temperature (above general average of maximum temperature) and the case numbers of bronchial asthma (unit= 10) or heart conditions (unit= 100) registered in health centers during August in 2002-2003. However, no such relation existed in 2004- 2006 (Fig. 66).

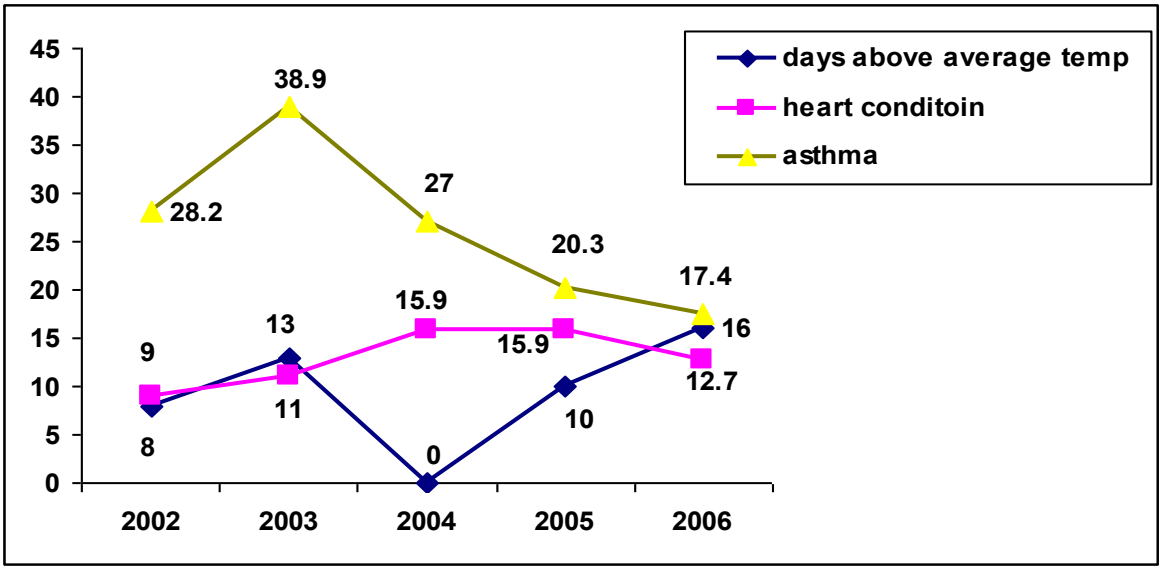


Fig. (66): the number of days with high temperature (above general average of maximum temperature) and the case numbers of bronchial asthma (unit= 10) or heart conditions (unit= 100) registered in health centers (unit= 100) during August in 2002- 2006

Heat waves: Figure 67 shows number of days with temperature between 40° to 43° C and days with temperature higher than 43° C in Damascus over 2000- 2006.

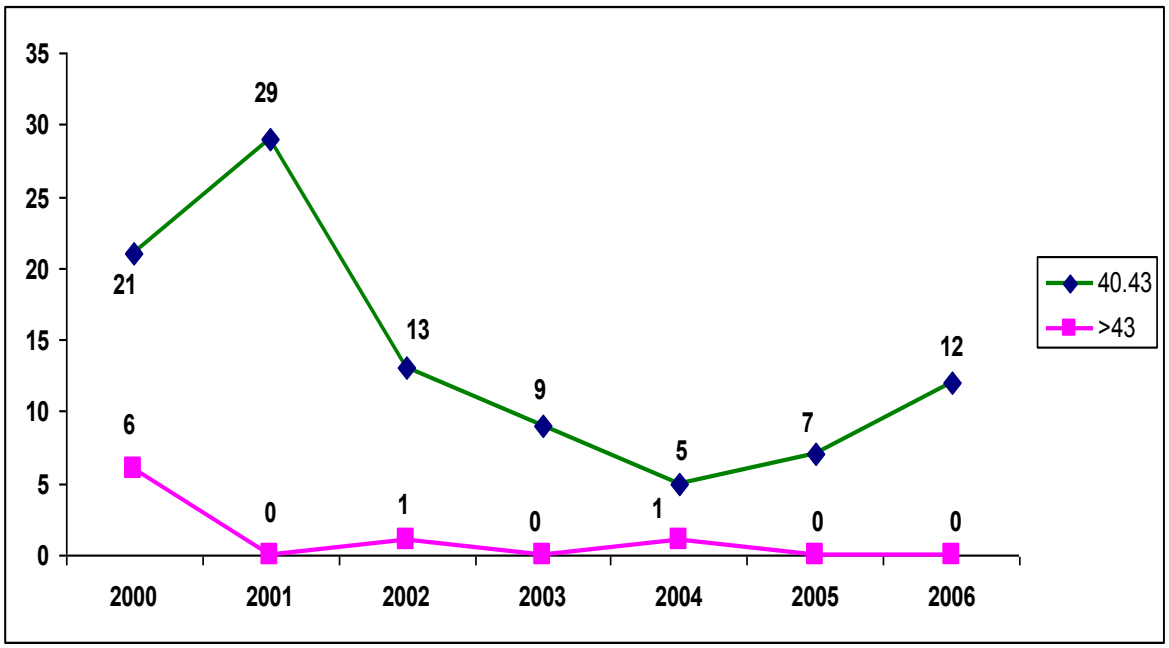


Fig. (67): Number of days with temperature between 40o to 43o C and days with temperature higher than 43o C in Damascus over 2000- 2006

As the number of hot days during summer in 2000- 2006 increased, a trend was noticed towards more cases of heart conditions in health centers (Fig. 68). Paradoxically more cases were recorded in 2004 than in 2003 despite that less hot days occurred. That may be attributed to the presence of one day with extreme temperature in 2004.

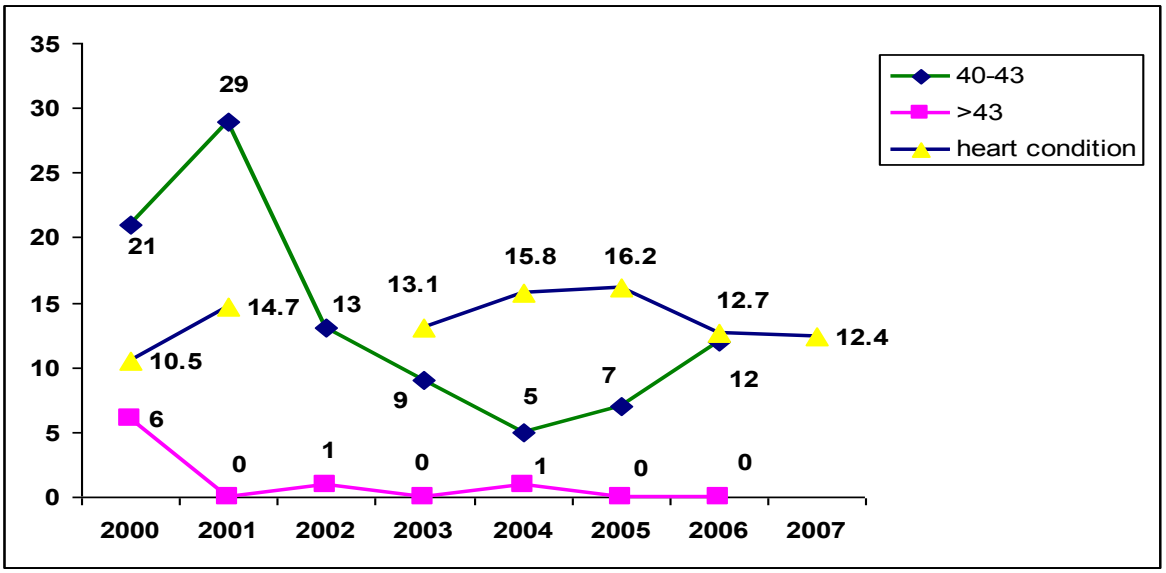


Fig. (68): Frequency of heart conditions (unit= 1000) recorded in Damascus (MOH) health centers over 2000- 2007 matched to days with temperature higher than 40o C

A clear positive relationship was noticed between number of days with very high temperature and number of hypertension cases in 2000- 2001. Hypertension case incidence went up in 2004 despite the drop noticed in temperature; the reason could be the extreme temperature recorded in one day in 2004 (Fig. 69).

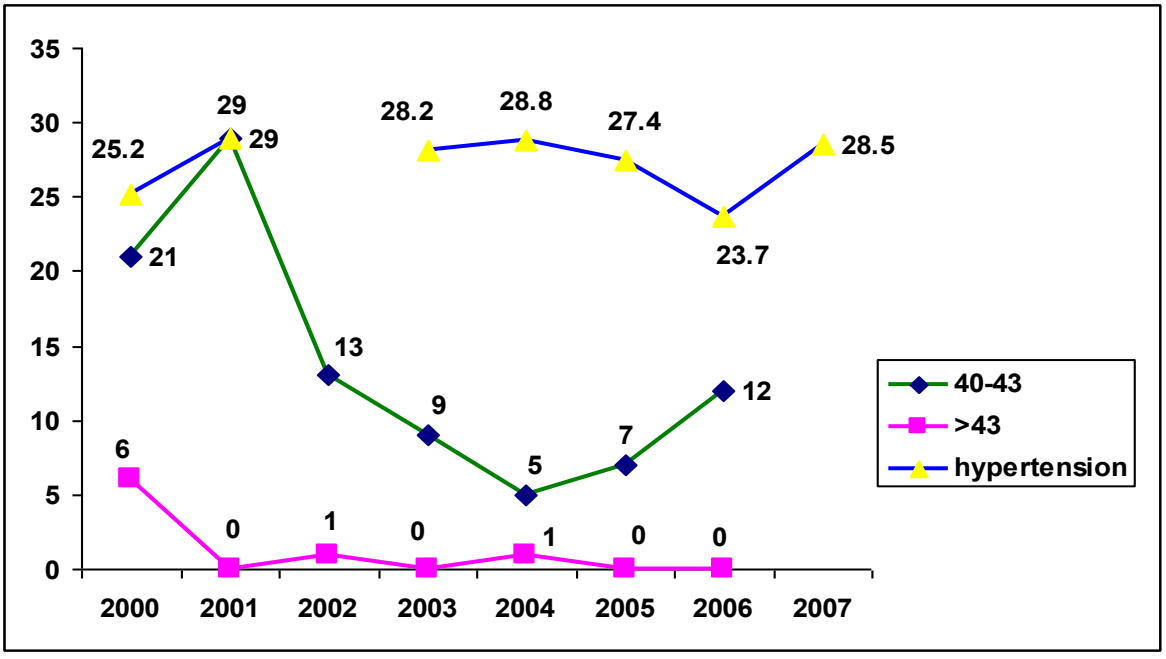


Fig. (69): Hypertension prevalence (unit= 1000) recorded in (MOH) health centers in Damascus matched to days with temperature higher than 40o C in 2000- 2006

The same positive relation was noticed regarding asthma cases and hot days in 2000- 2005 unlike the year 2006, which calls for more profound investigation to reveal the underlying causes (Fig. 70).

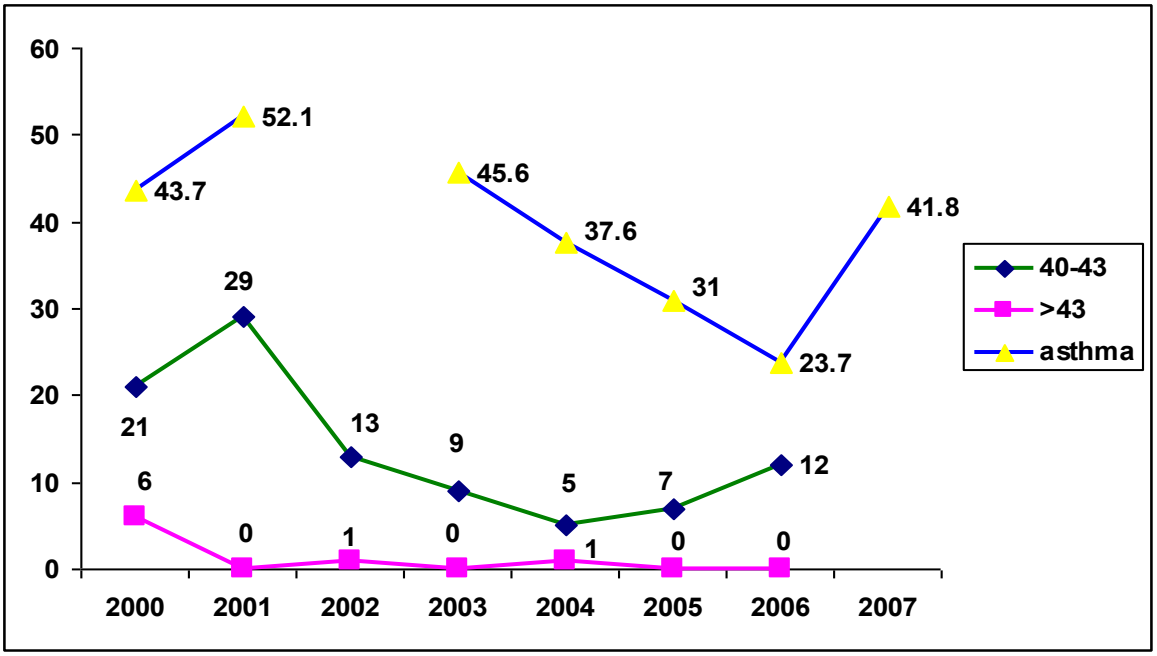


Fig. (70): Asthma prevalence (unit= 1000) recorded in (MOH) health centers in Damascus matched to days with temperature higher than 40o C in 2000- 2006

Heat wave analysis: A trend towards slight rise in morbidity[xxii] was noticed during days with extreme high temperature (Fig. 71).

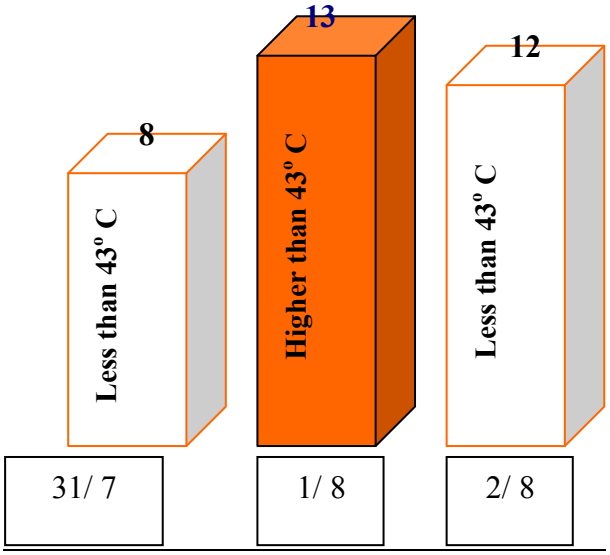


Fig. (71): Mortality cases during a short moderate hot wave in Damascus in August 2002

This rise was more significant in extreme temperature days in 2004 (Fig. 72) implying generally higher mortality rates in extremely hot days.

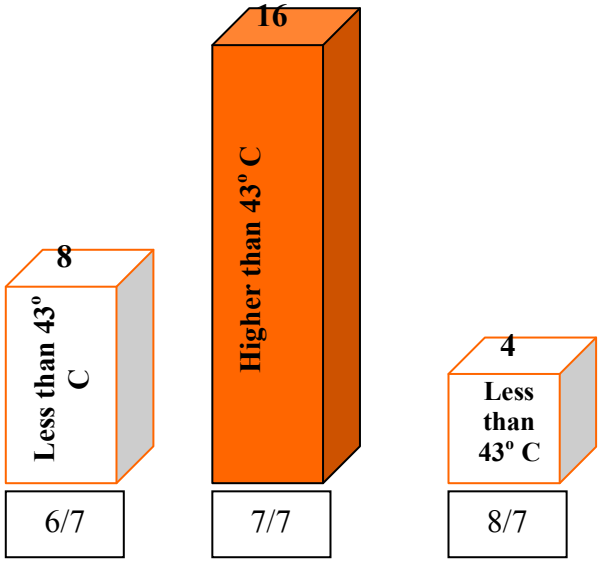


Fig. (72): Mortality cases during a short moderate hot wave in Damascus in July 2004

The relationship was not as clear in July in 2000. However, no death cases were recorded on June 30 (perhaps it was a holiday) which might be the reason of death case accumulation the next day (Fig. 73).

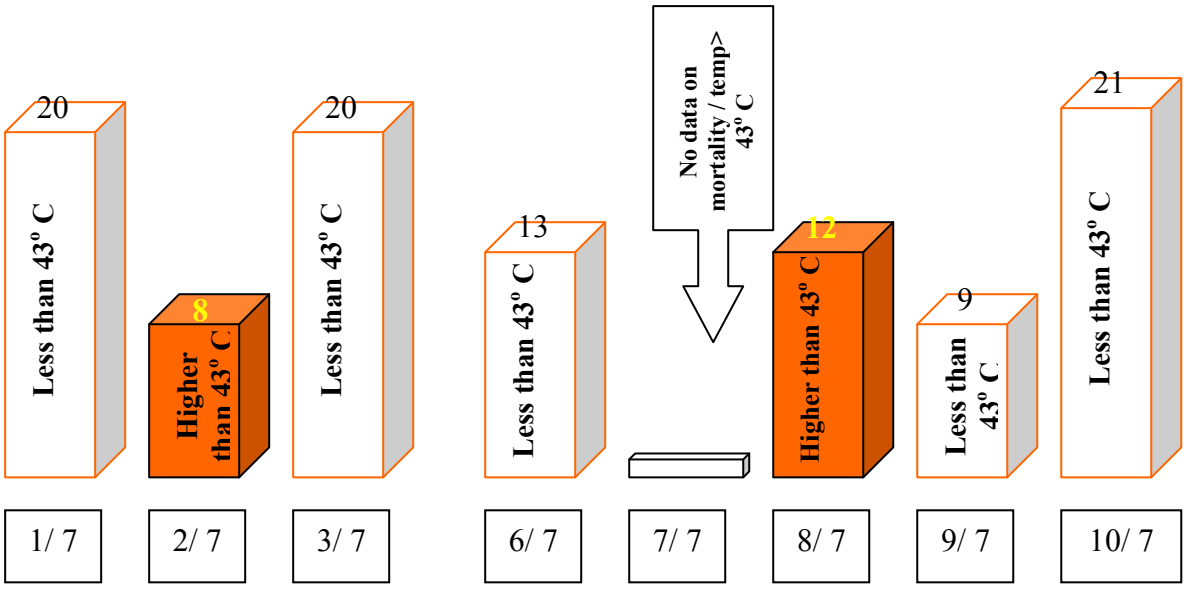


Fig. (73): Mortality cases during a extreme (> 43o C) short (1- 2 days) and of medium long (> 3 days) heat waves in Damascus in July 2000

Death cases were noticed to climb up during the extreme temperature (> 43 C °) days in the heat wave that happened at the end of July and the beginning of August in the same year (Fig. 74).

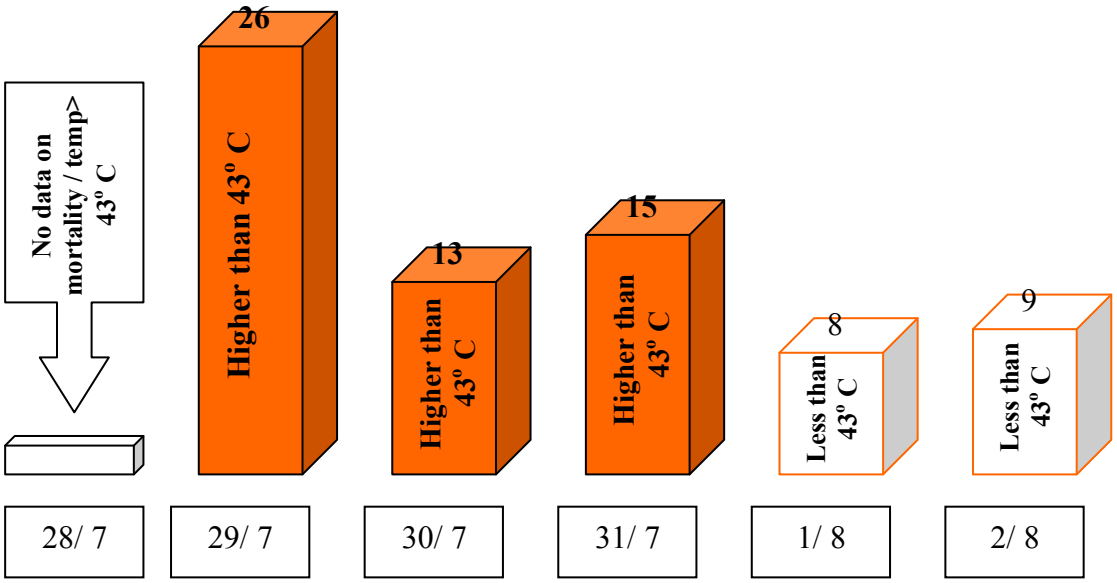


Fig. (74): Feath cases accompanying extreme heat wave (>43 C°) with medium length (> 3 days) in Damascus in July and August 2000

Mortality [xxiii]: Damascus death cases (unit=10) with number of days when temperature was higher than 40 C ° in June, July and August in 2000, (Fig. 75).

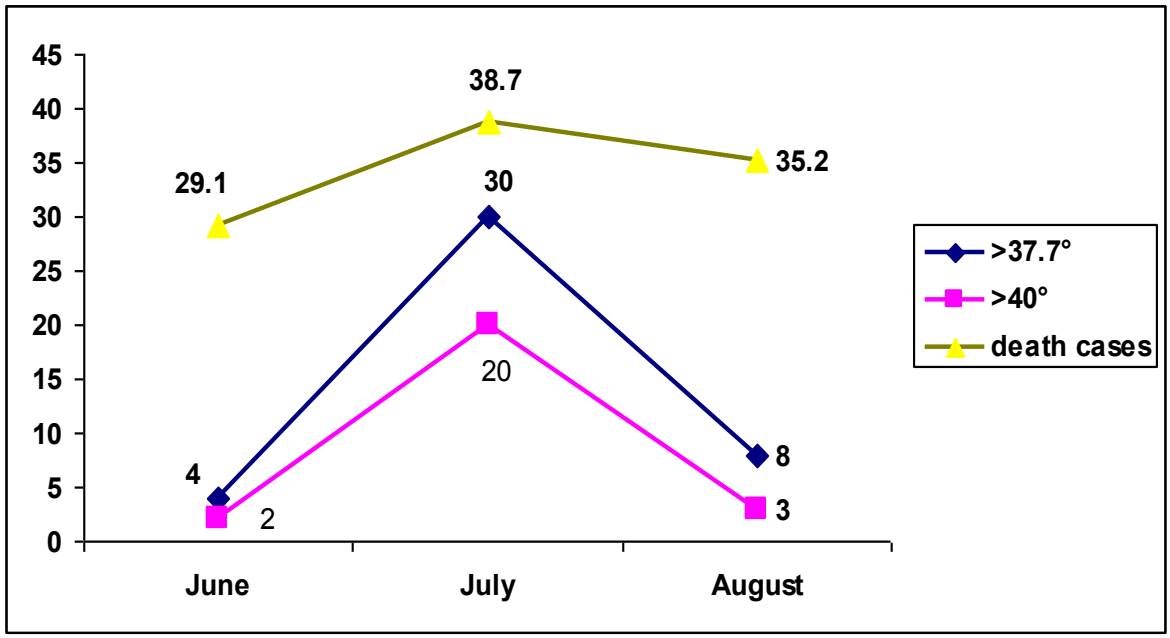


Fig. (75): Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C ° in June, July and August in 2000

Damascus death cases (unit=10) with number of days when temperature was higher than 40 C ° in June, July and August in 2001 (Fig. 76).

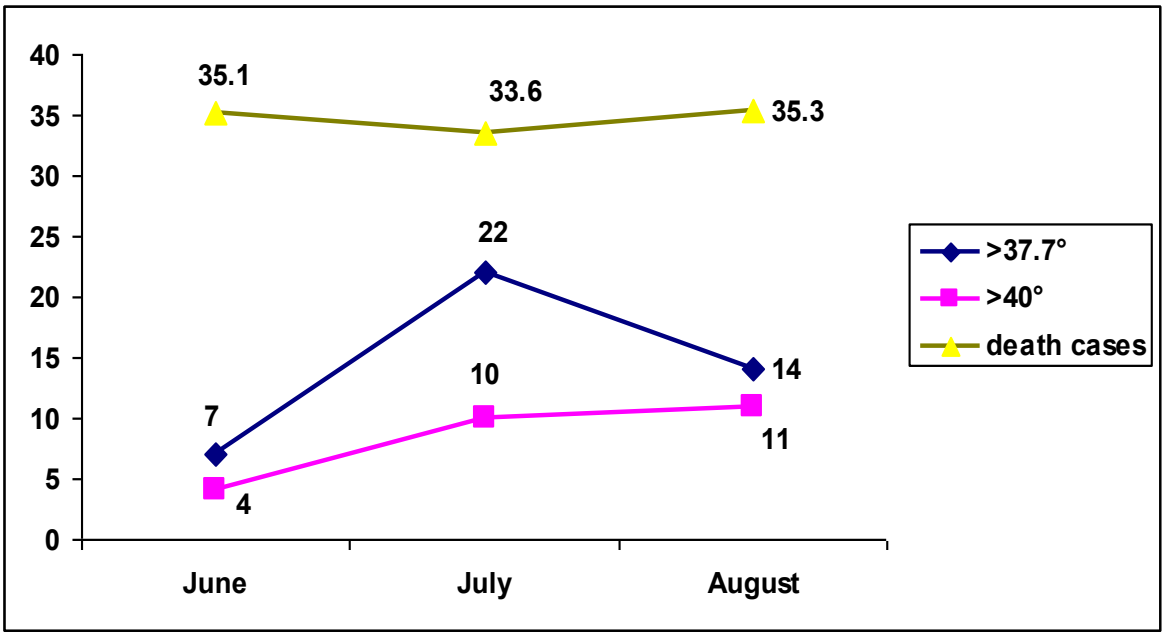


Fig. (76): Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in June, July and August in 2001

Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in July and August in 2002 (Fig. 77).

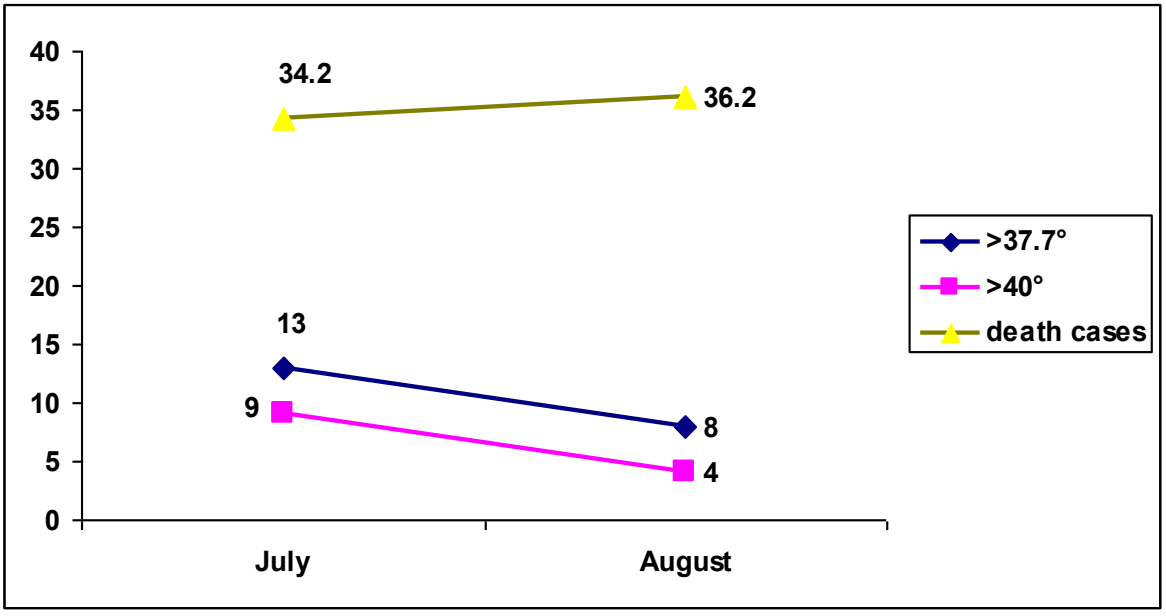


Fig. (77): Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in July and August in 2001

Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in June, July and August in 2003 (Figure 78).

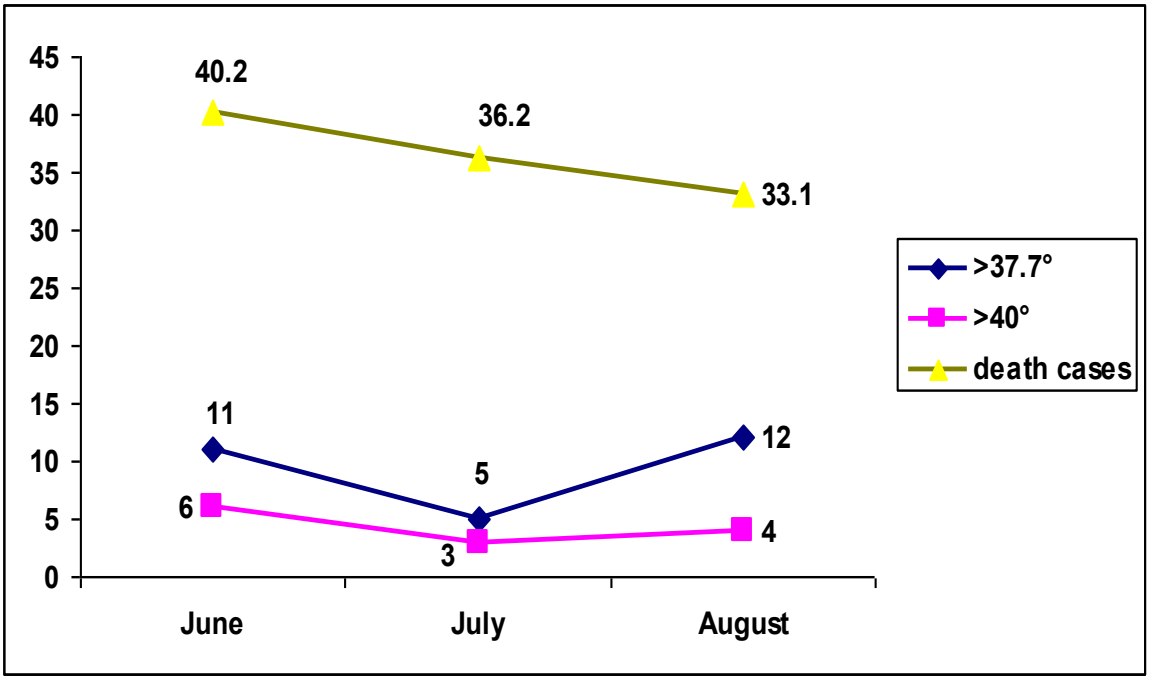


Fig. (78): Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in June, July and August in 2003

Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in July 2004 (Fig. 78).

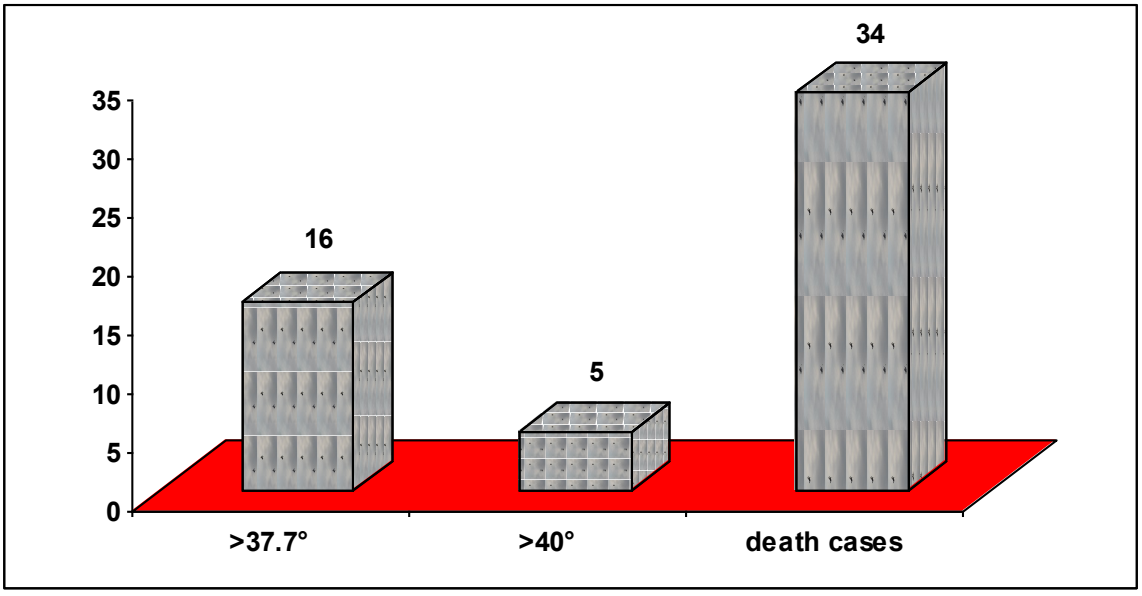


Fig. (78): Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in July 2004

Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in June, July and August in 2006 (Figure 79).

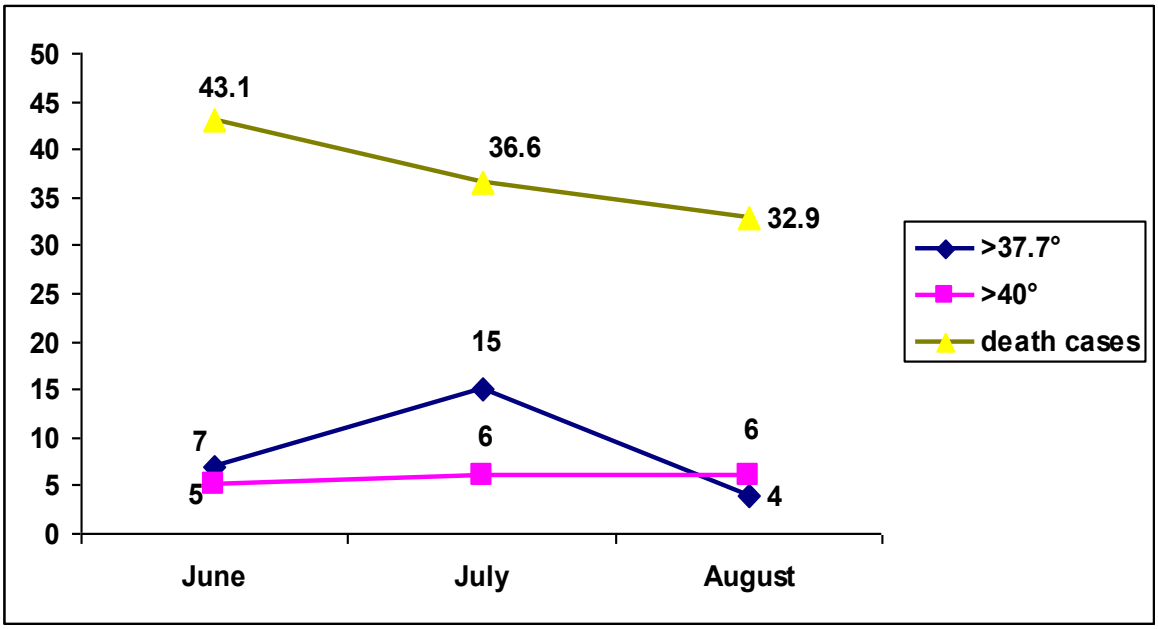


Fig. (79): Damascus death cases (unit= 10) with number of days when temperature was higher than 40 C° in June, July and August in 2006

Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C°, and number of days that had temperature higher than 43° C matched to death cases (unit=10) in Damascus in June over 2000-2006 (Figure 80).

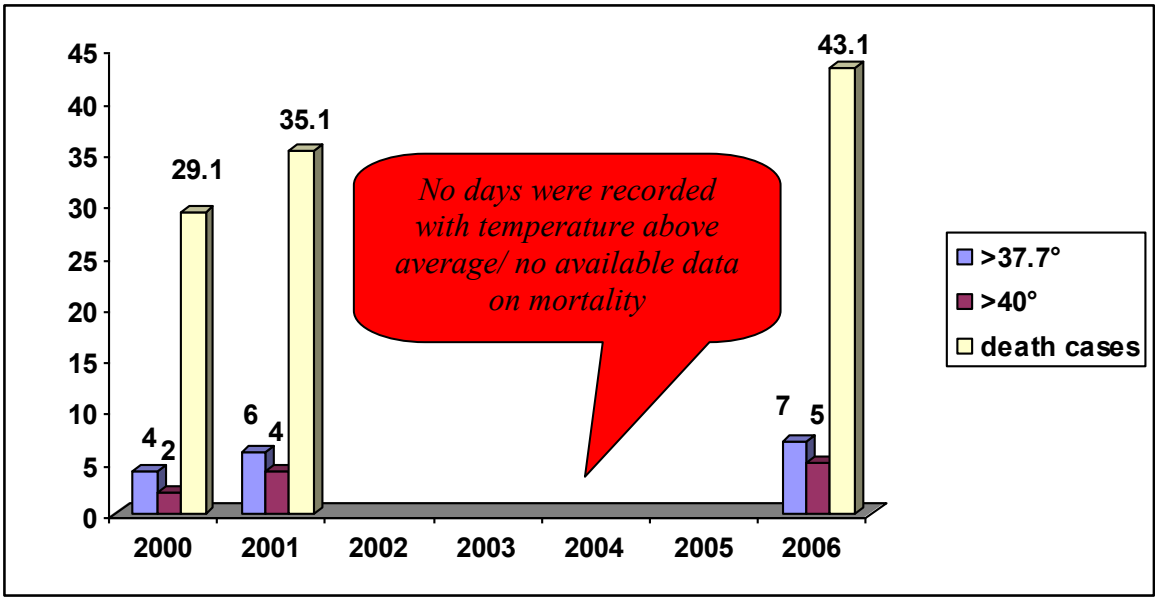


Fig. (80): Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C°, and number of days that had temperature higher than 43 C° matched to death cases(unit= 10) in Damascus in June over 2000- 2006

Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C°, and number of days that had temperature higher than 43° C matched to death cases(unit= 10) in Damascus in July over 2000- 2006 (Fig. 81).

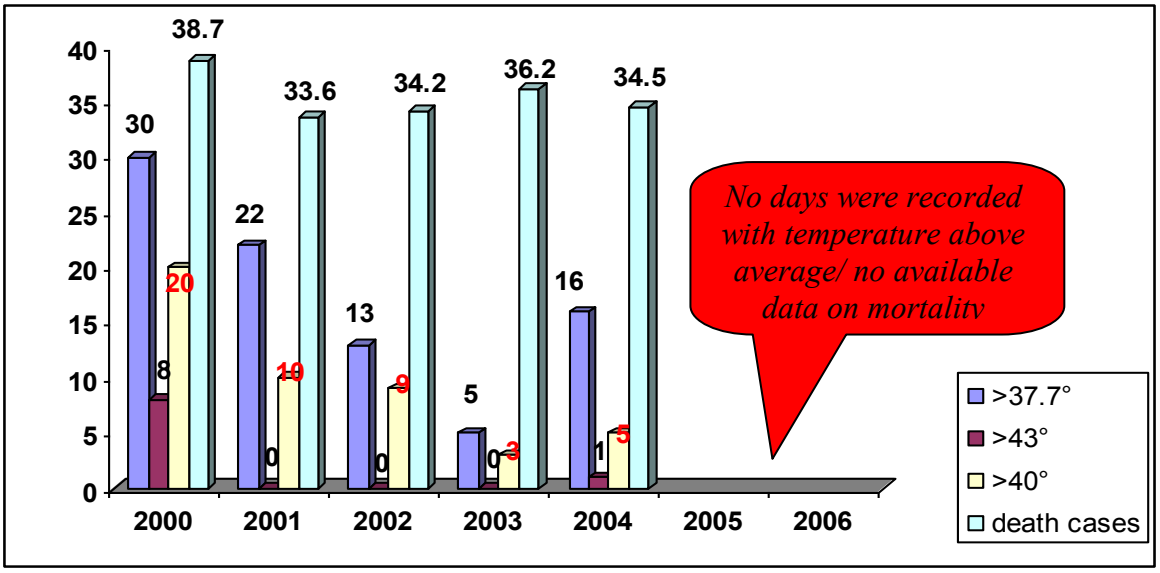


Fig. (81): Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C °, and number of days that had temperature higher than 43 C ° matched to death cases(unit= 10) in Damascus in July over 2000- 2006

Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C °, and number of days that had temperature higher than 43 C ° matched to death cases(unit= 10) in Damascus in August over 2000- 2006 (Fig. 82).

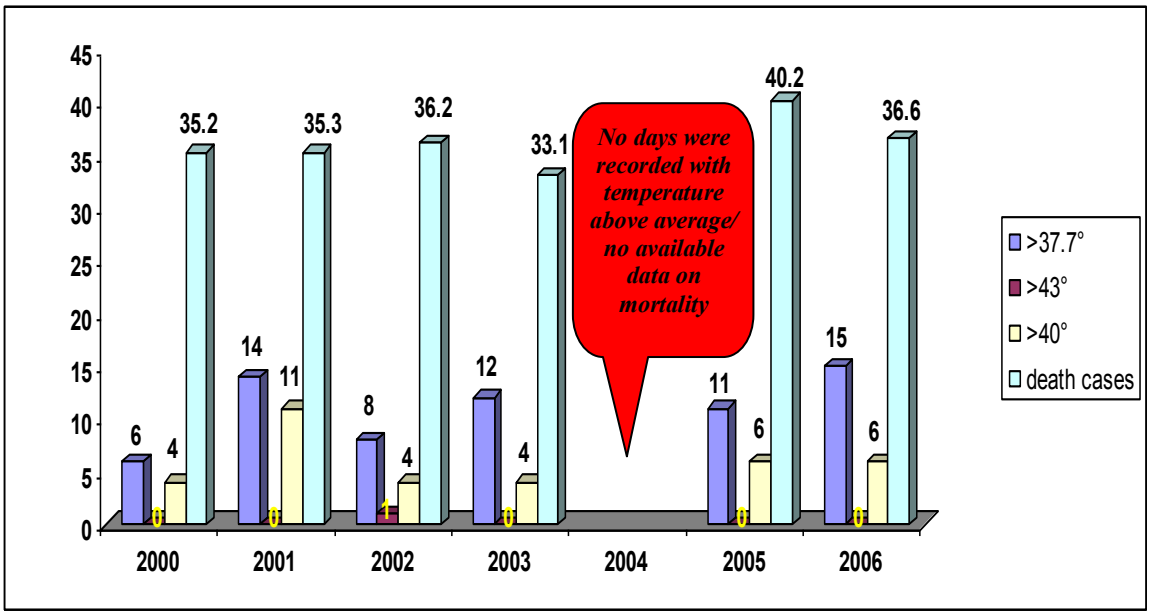


Fig. (82): Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C °, and number of days that had temperature higher than 43 C ° matched to death cases(unit= 10) in Damascus in August over 2000- 2006

Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C °, and number of days that had temperature higher than 43 C ° matched to death cases(unit= 10) in Damascus over 2000- 2006 (Figure 83).

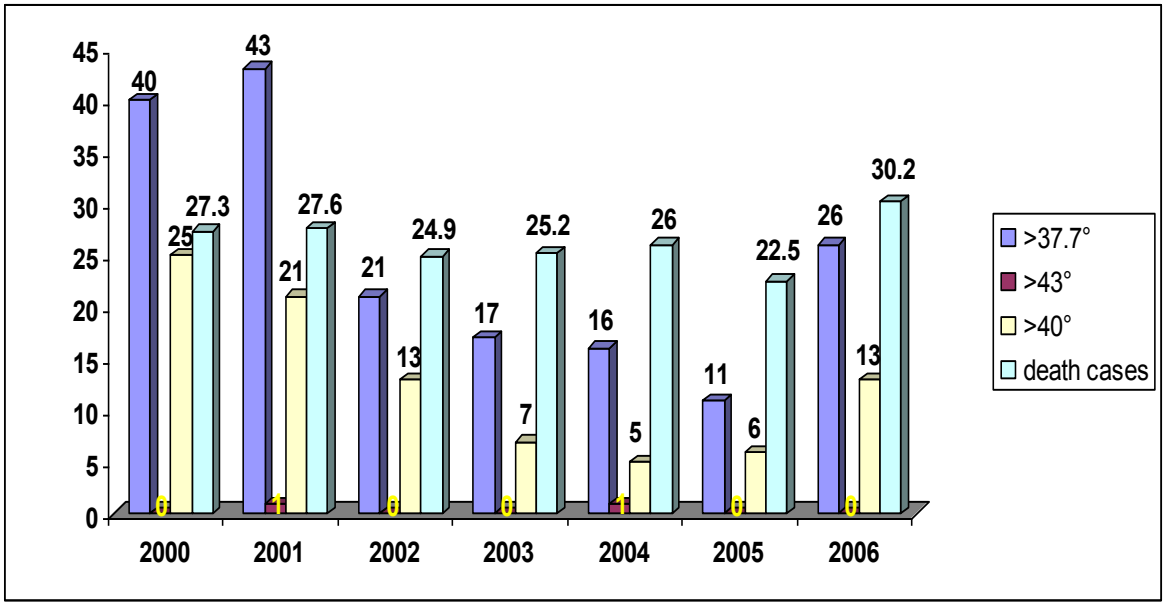


Fig. (83): Number of days that had higher temperature than the yearly average for maximum temperature, number of days that had temperature higher than 40 C°, and number of days that had temperature higher than 43 C° matched to death cases(unit= 10) in Damascus over 2000- 2006

7.2. Health impact of low-grade temperature

Morbidity: No relation could be noticed between numbers of days with recorded temperature below zero degree Celsius and asthma cases recorded in (MOH) health centers in Damascus over 2000- 2007 (Fig. 84).

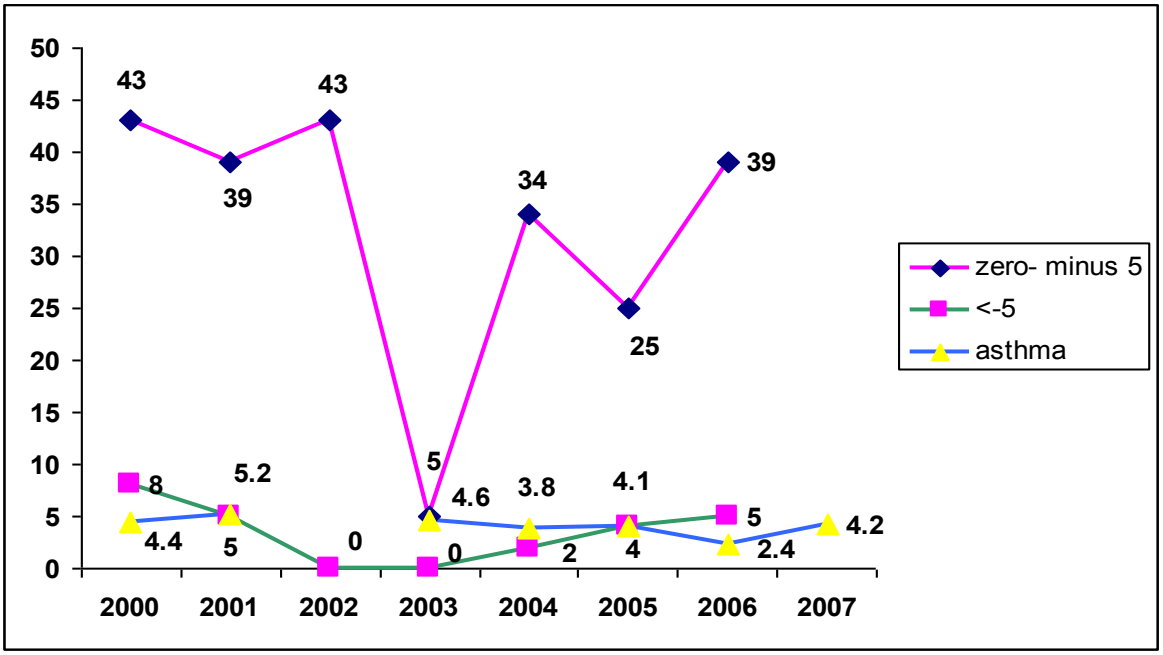


Fig. (84): Numbers of days with recorded temperature below zero degree Celsius matched to asthma cases (unit= 1000) recorded in (MOH) health centers in Damascus over 2000- 2007

There was a general blurred trend towards the rise of heart condition cases recorded in (MOH) health centers in Damascus during extremely cold days (temperature below minus five Celsius) over 2000- 2007 (Fig. 85).

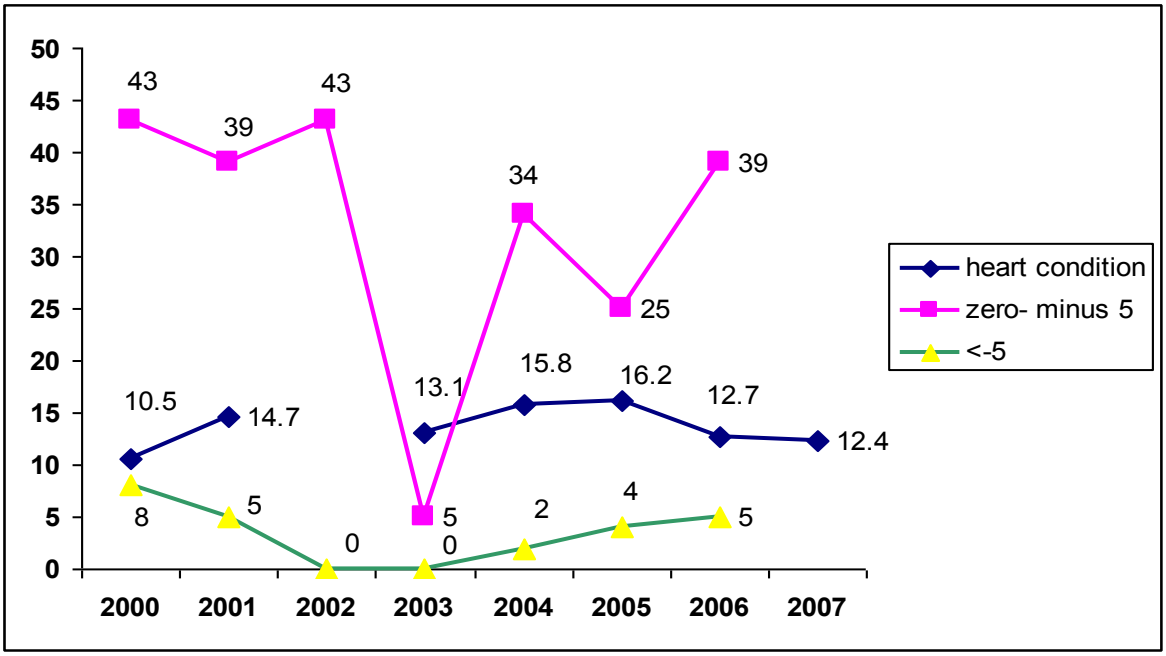


Fig. (85): Number of days when recorded temperature was below zero Celsius matched to heart condition (unit= 1000) cases recorded in (MOH) health centers in Damascus over 2000- 2007

Figure (86) illustrates number of days when recorded temperature was below zero Celsius matched to hypertension cases recorded in (MOH) health centers in Damascus over 2000- 2007.

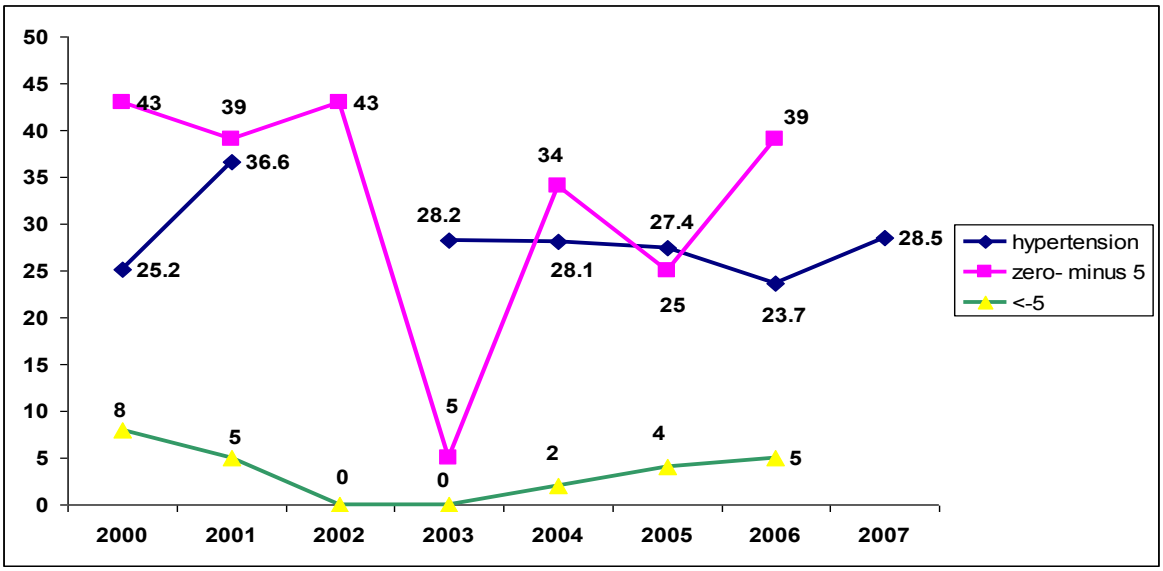


Fig. (86): Number of days when recorded temperature was below zero Celsius matched to hypertension cases (unit= 1000) recorded in (MOH) health centers in Damascus over 2000- 2007

No relation could be found between hypertension and asthma cases recorded in (MOH) health centers in Damascus over 2000- 2007 and number of days with extremely low temperature during January, February, and March.

Cold waves and mortality: There was a positive relationship between numbers of cold days (zero- minus five Celsius) with recorded mortality cases in Damascus during January, February, and March in 2000 (Figure 87).

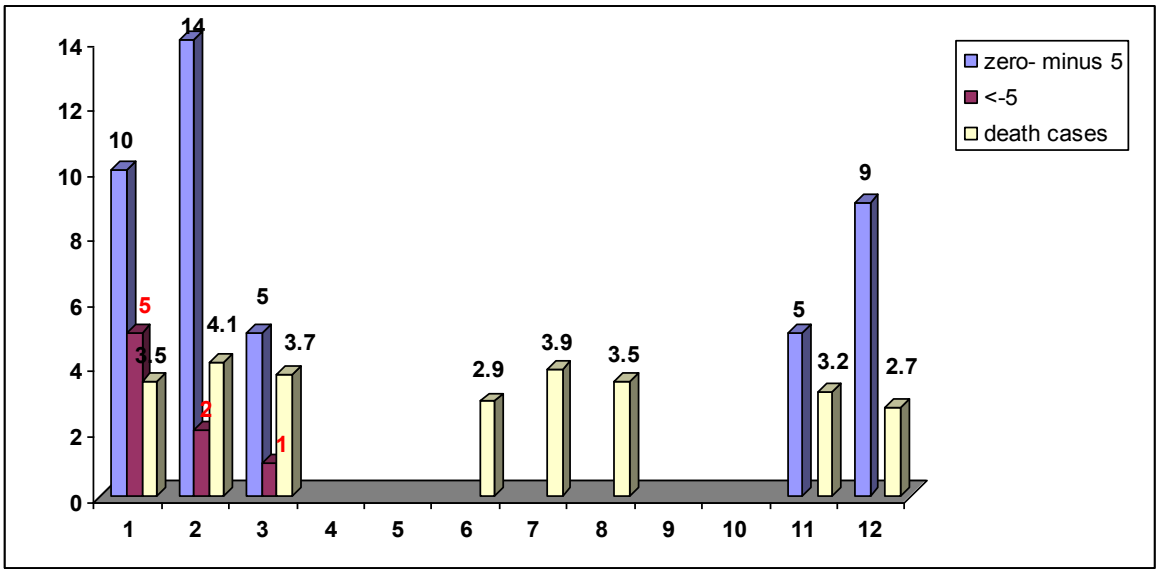


Fig. (87): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit= 10) in Damascus in 2000

However, this relation was not as clear in October and November 2001 (Figure 88).

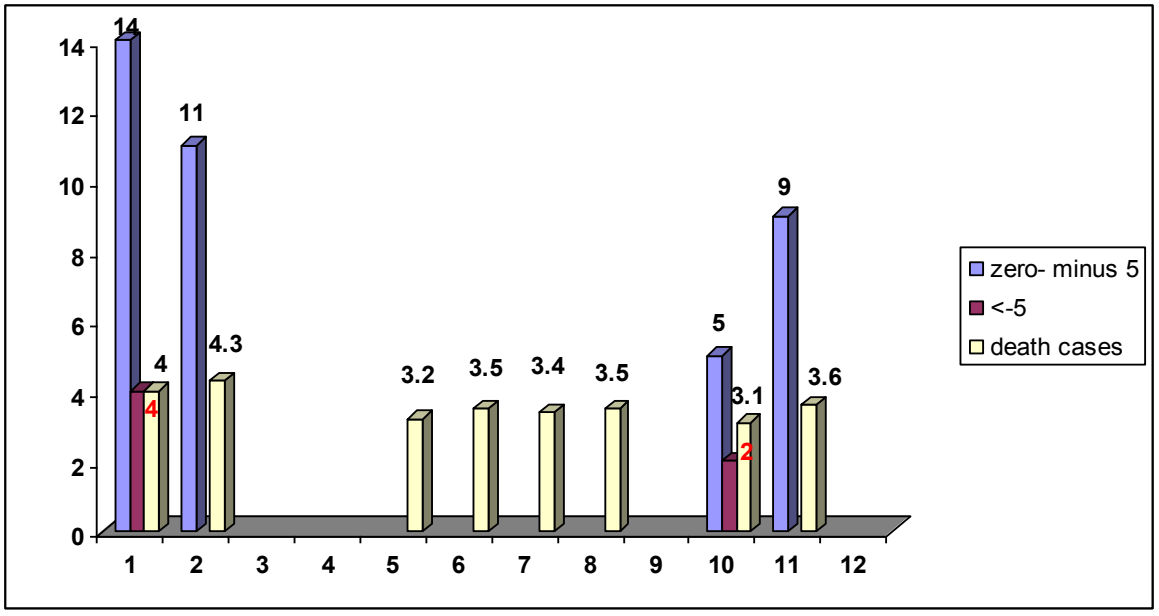


Fig. (88): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit= 10) in Damascus in 2001

This relation was weaker and even blurred sometimes in 2002 (Figure 89).

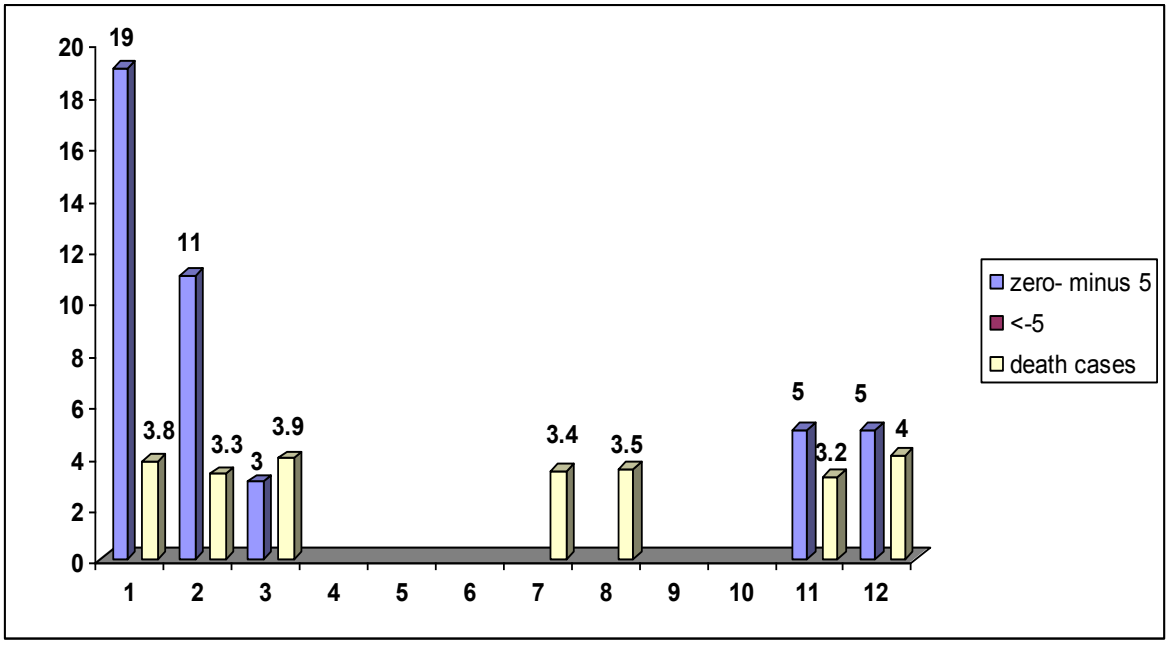


Fig. (89): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit= 10) in Damascus in 2002

The same relation was stronger in 2003 (Figure 90).

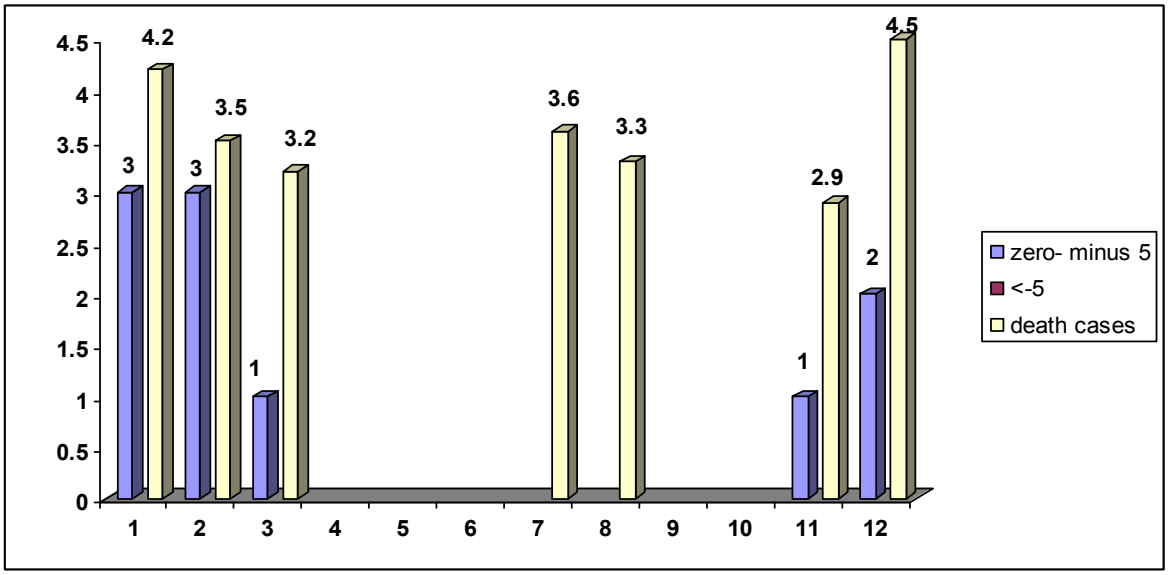


Fig. (90): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit= 10) in Damascus in 2003

In 2004, the relation was as strong with some exceptions (Figure 91).

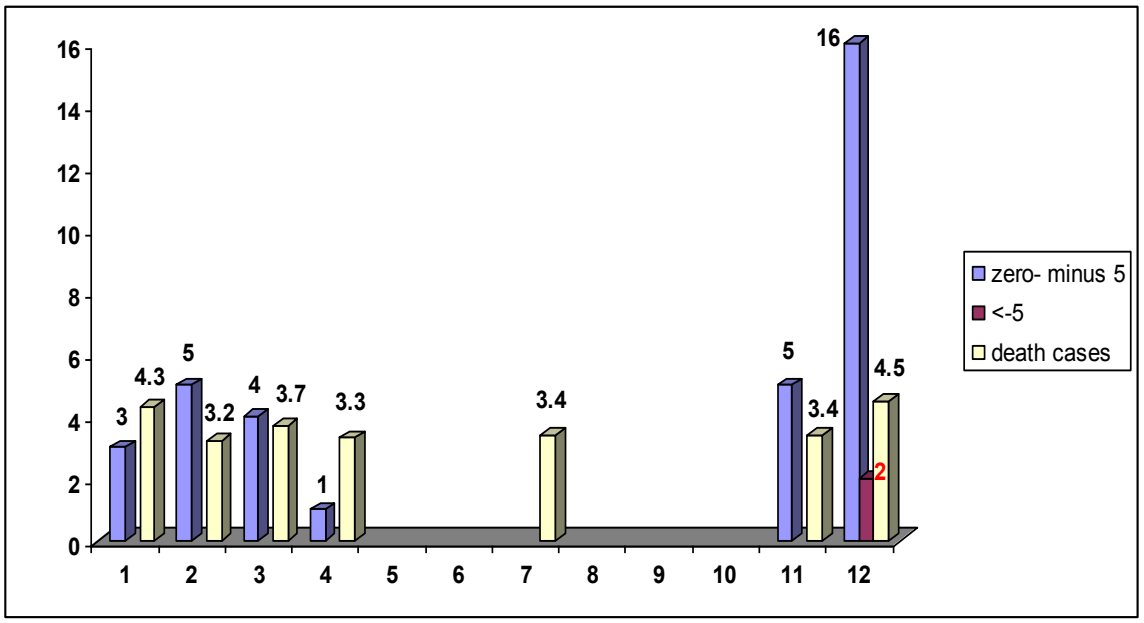


Fig. (91): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit=10) in Damascus in 2004

In 2005, the relation had 2 phases; clear and blurred (Figure 92).

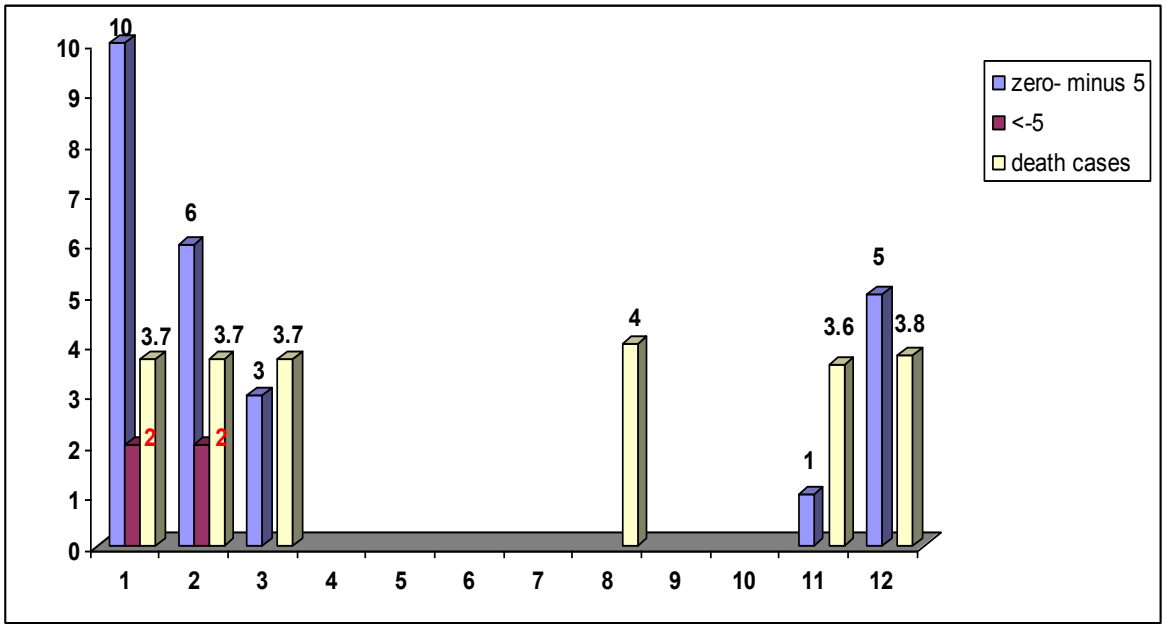


Fig. (92): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit= 10) in Damascus in 2005

On the other hand, the relation was inverted in 2006 (Figure 93).

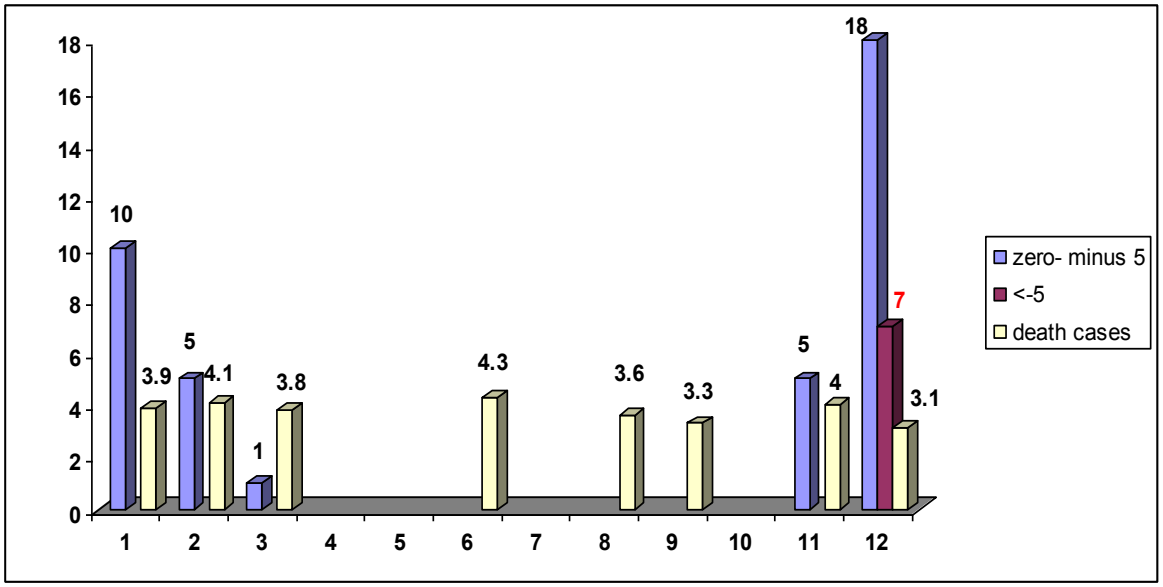


Fig. (93): Numbers of cold days (zero-minus five Celsius) matched to monthly recorded mortality cases (unit= 10) in Damascus in 2006

Cold wave analysis: There was a clear positive relationship between number of days that had temperature lower than the minimal average (lower than zero Celsius) and number of mortality cases recorded in Damascus during January 2002. Furthermore, the lowest the temperature the highest the death cases (Figure 94. 95 and 96).

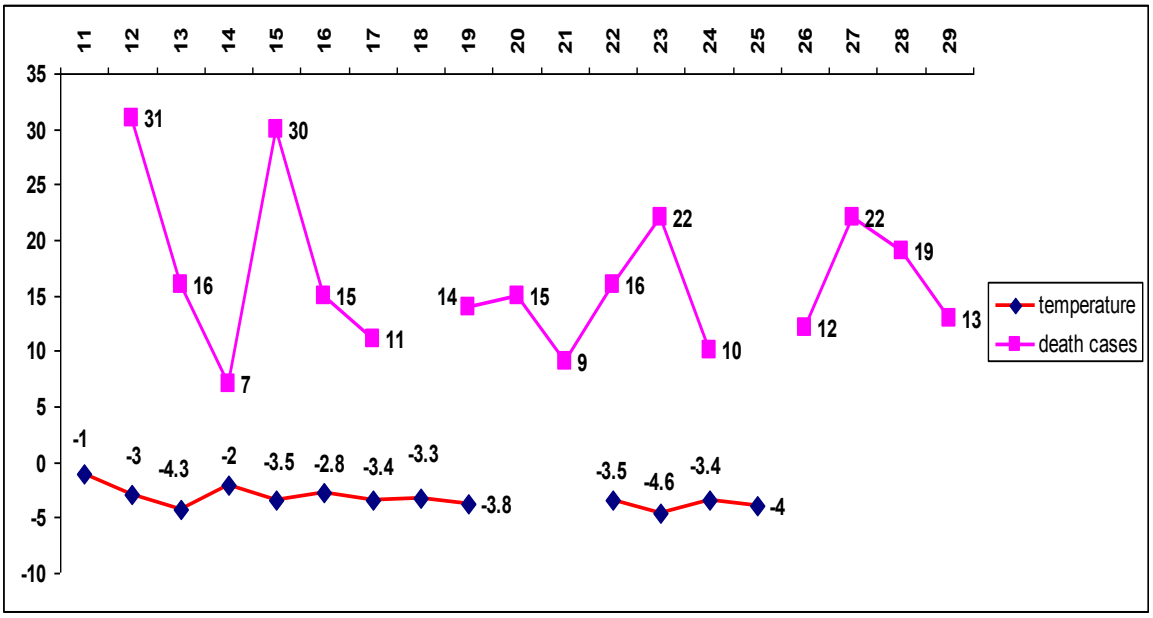


Fig. (95): Death cases during a long severe cold wave in January 2002

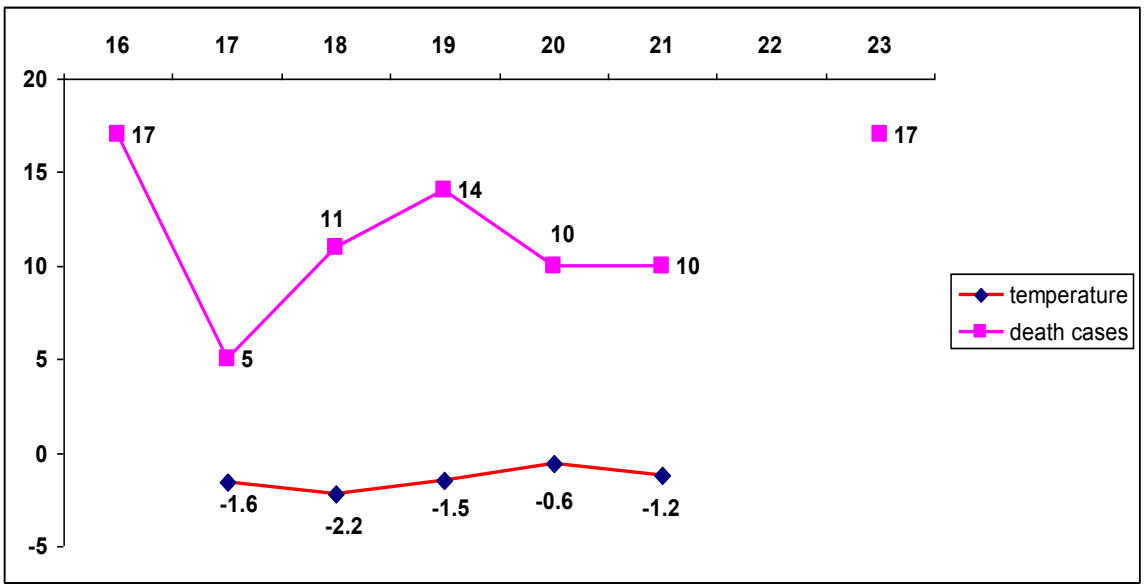


Fig. (96): Death cases during a long severe cold wave in November 2002

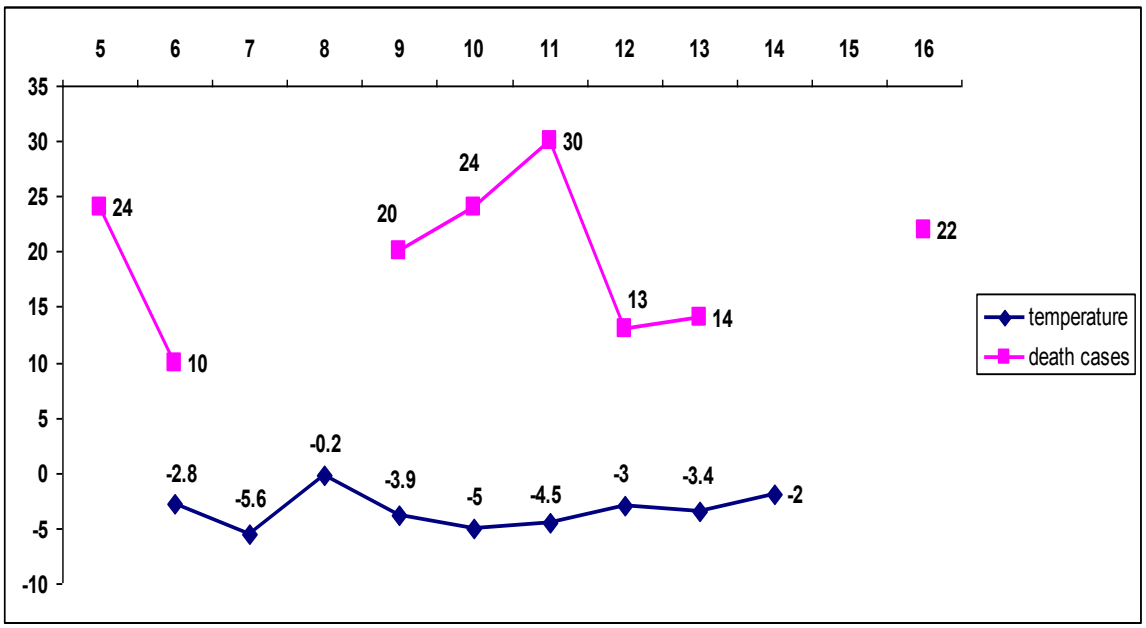


Fig. (97): Death cases during a long severe cold wave in November 2002

7.3. Sand storms and their health impact

The analysis of weather data related to sand storms revealed that *Deir Ezzor* is the governorate worst affected by these features. That called for linking these data with health data especially heart condition, angina pectoris, and asthma.

A positive relationship was noticed between asthma cases recorded in hospitals and health centers and the frequency of sand storm days in *Deir Ezzor* over 2000- 2007 (Figure 98).

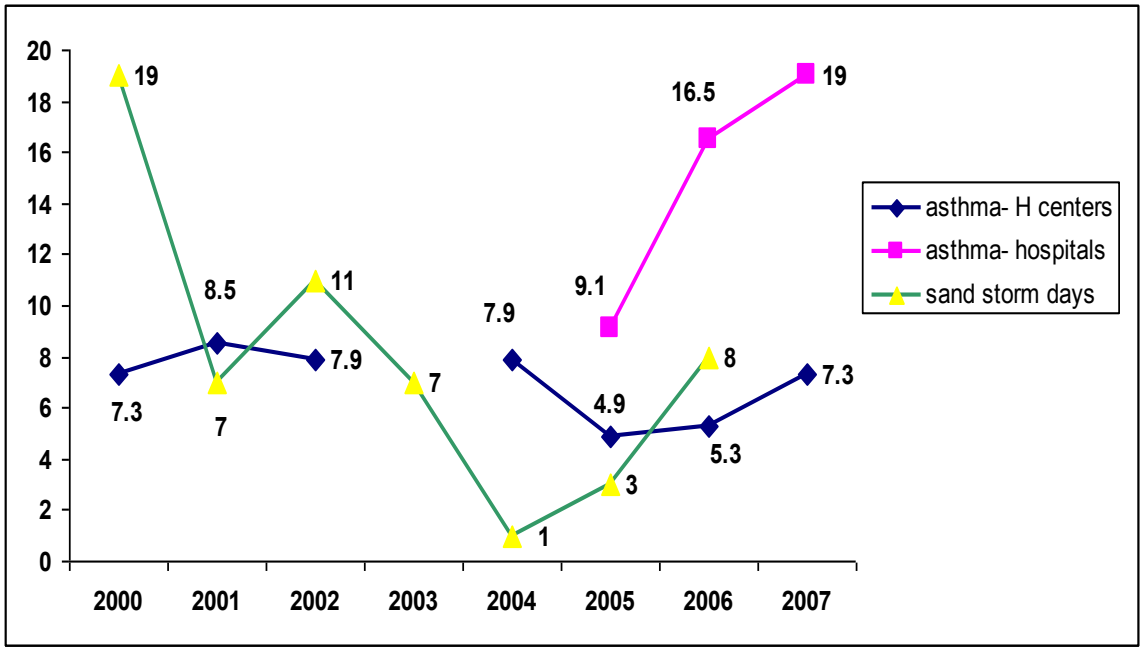


Fig. (98): Number of asthma cases (unit= 100) recorded in (MOH) health centers and number of asthma cases (unit= 100) *recorded in hospitals matched to number of days with sand storms in Deir Ezzor over 2000- 2007*

There was a similar relationship, though less specified, between sand storm days an heart condition cases recorded in (MOH) health centers and angina pectoris cases recorded in hospitals in *Deir Ezzor* over 2000- 2007 (Fig. 99).

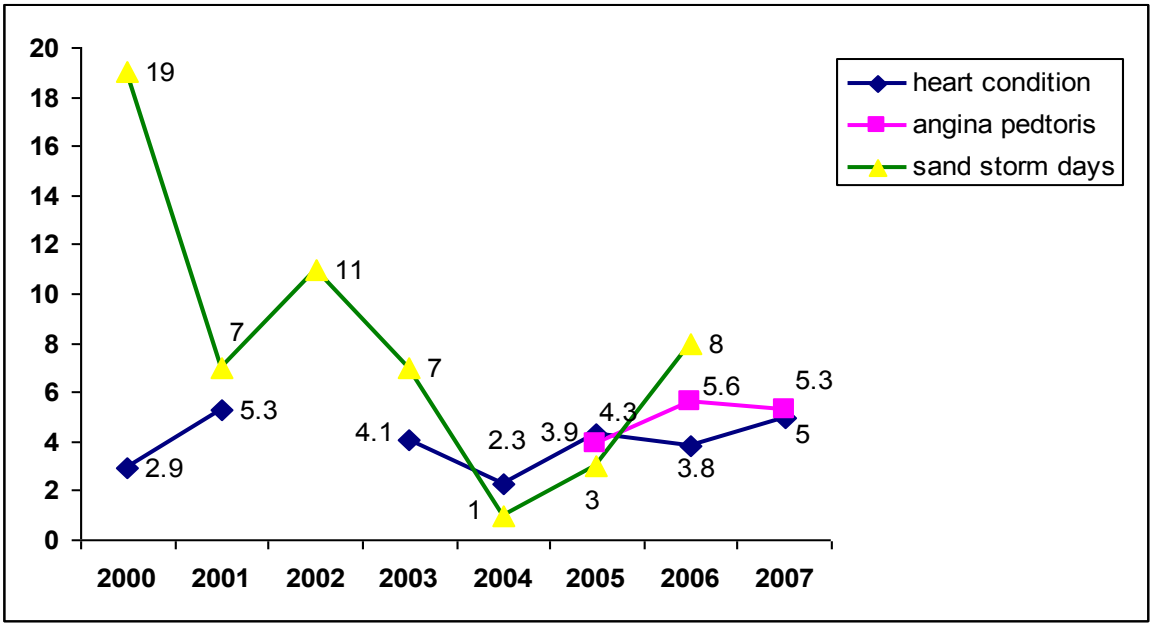


Fig. (99): Number of heart condition cases (unit=100) recorded in (MOH) health centers, and number of angina pectoris cases (unit=100) *recorded in hospitals matched to sand storm days, Deir Ezzor, 2000- 2007*

7.4. Hazy weather and its health impact

Regarding hazy days, the choice was to study the situation in the governorates that were most affected. Aleppo was the leading governorate regarding hazy day frequency, which allowed expecting more heart condition, angina pectoris, and asthma cases than other governorates. It was followed by *Deir Ezzor* then Damascus and Palmyra finally. The statistical analysis of data of the mentioned areas suggest a potential positive relationship

between hazy days on one side and number of heart condition, bronchial asthma, and mortality cases on the other side, especially when high temperature is present (Fig. 100, 101).

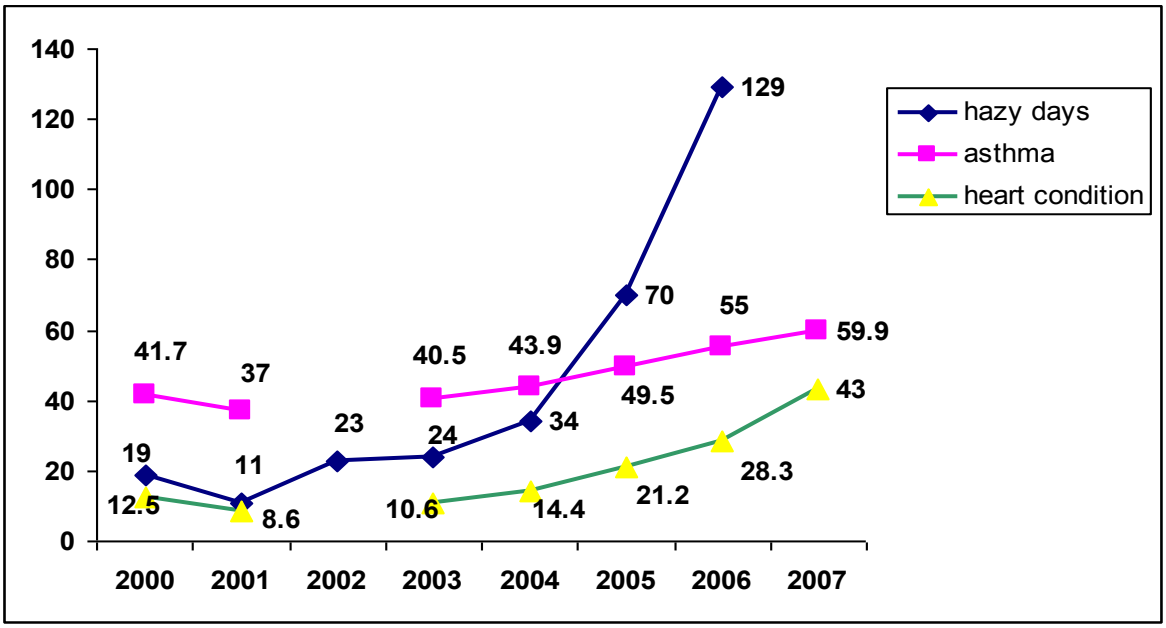


Fig. (100): Heart condition cases (unit=100) and asthma cases (unit= 100) recorded in (MOH) health centers in Aleppo governorate matched to hazy days over 2000- 2007

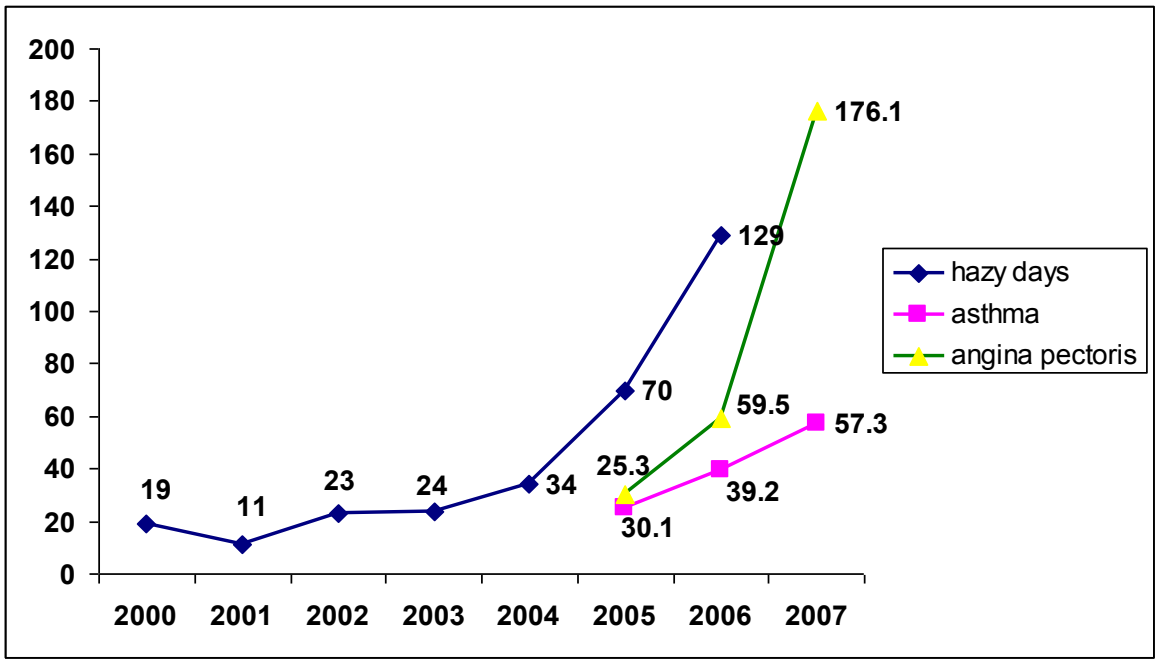


Fig. (101): Angina pectoris cases (unit100) recorded in hospitals and asthma cases (unit= 100) recorded in (MOH) health centers in Aleppo governorate matched to hazy days over 2000- 2007

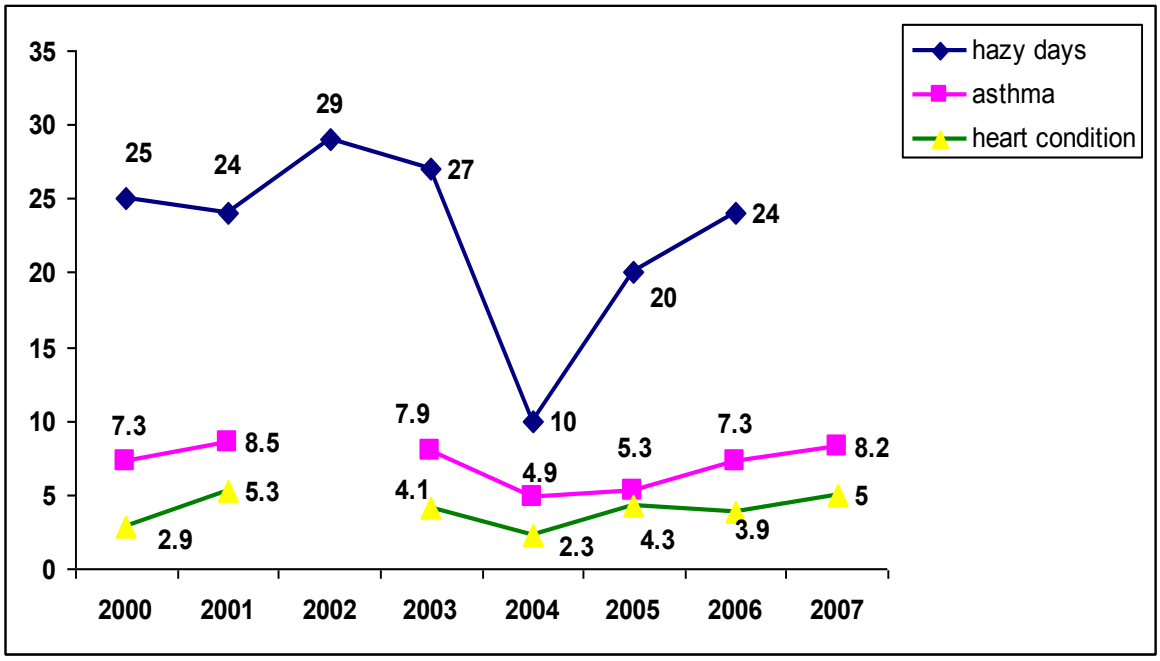


Fig. (102): Heart condition cases (unit=100) and asthma cases (unit= 100) recorded in (MOH) health centers in *Deir Ezzor* governorate matched to hazy days over 2000- 2007

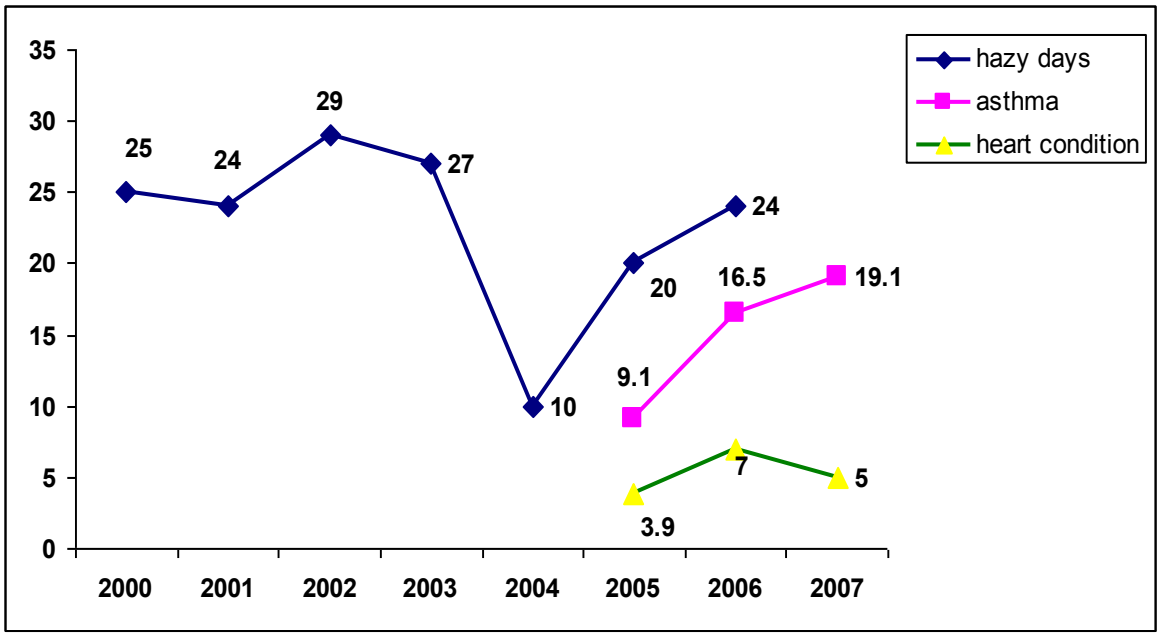


Fig. (103): Heart condition cases (unit= 100) and asthma cases (unit= 100) recorded in hospitals in *Deir Ezzor* governorate matched to hazy days over 2000- 2007

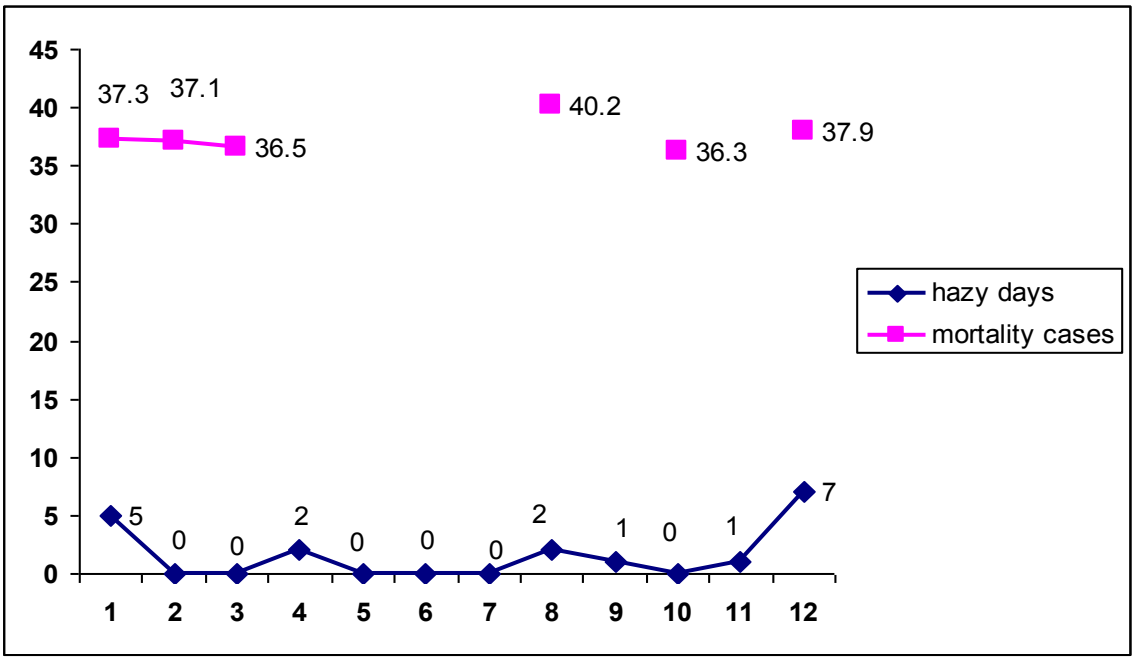


Fig. (104): Monthly mortality cases (unit= 10) matched to hazy days in Damascus in 2005

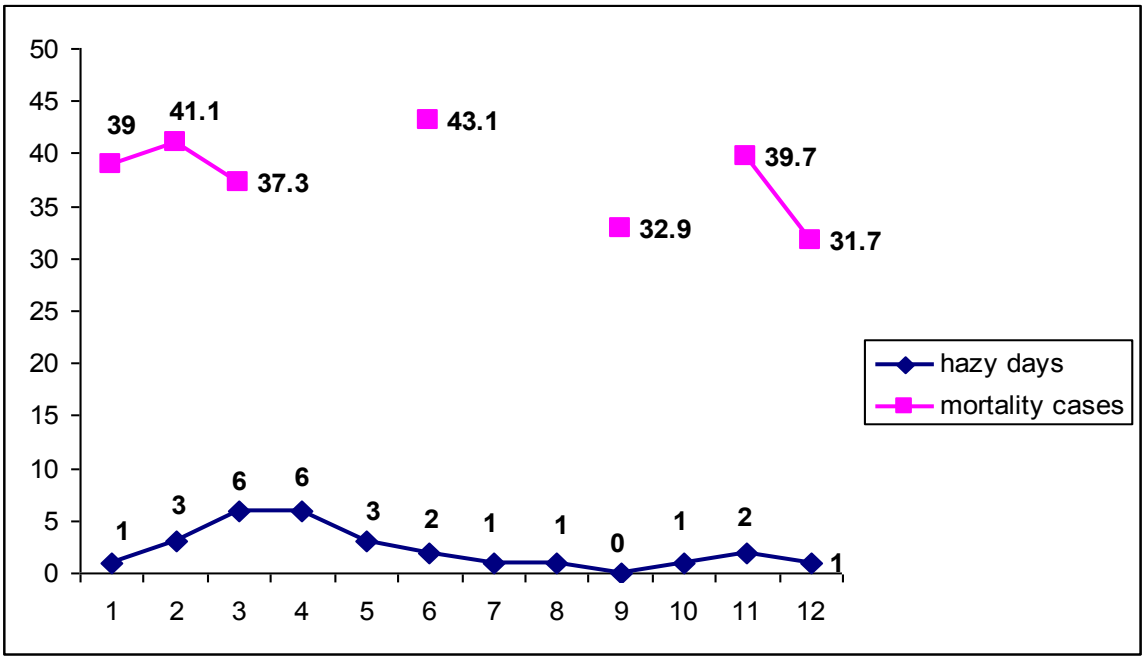


Fig. (105): Monthly mortality cases (unit= 10) matched to hazy days in Damascus in 2006

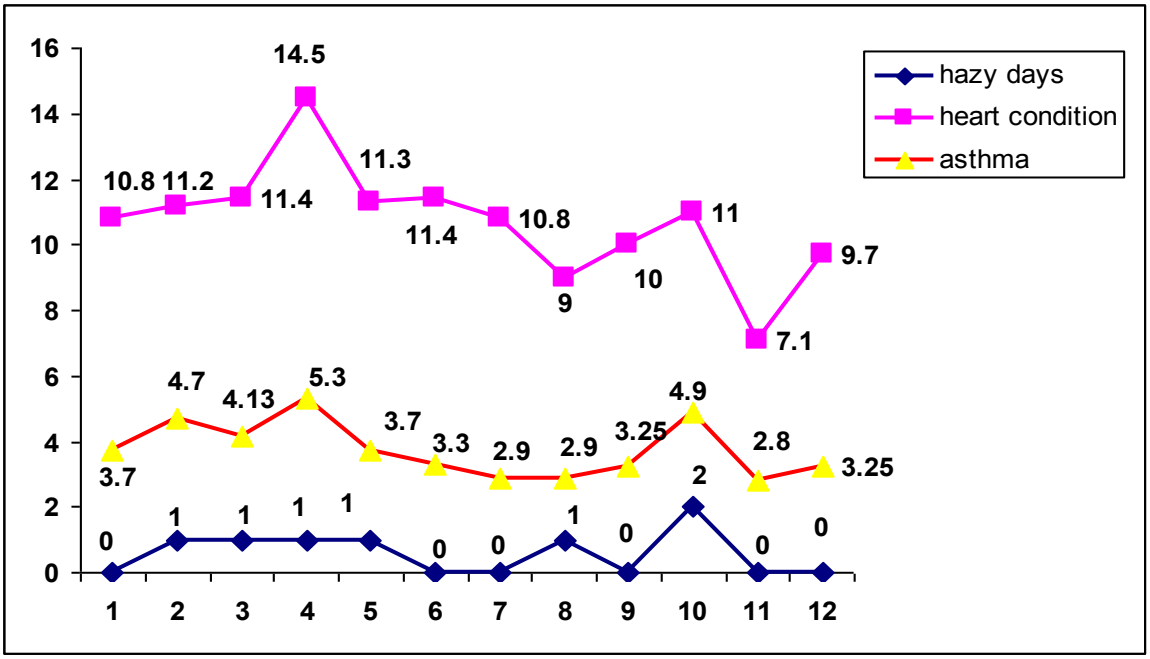


Fig. (106): Heart condition cases (unit= 100) and asthma cases (unit= 100) recorded monthly in Damascus matched to hazy days in 2002

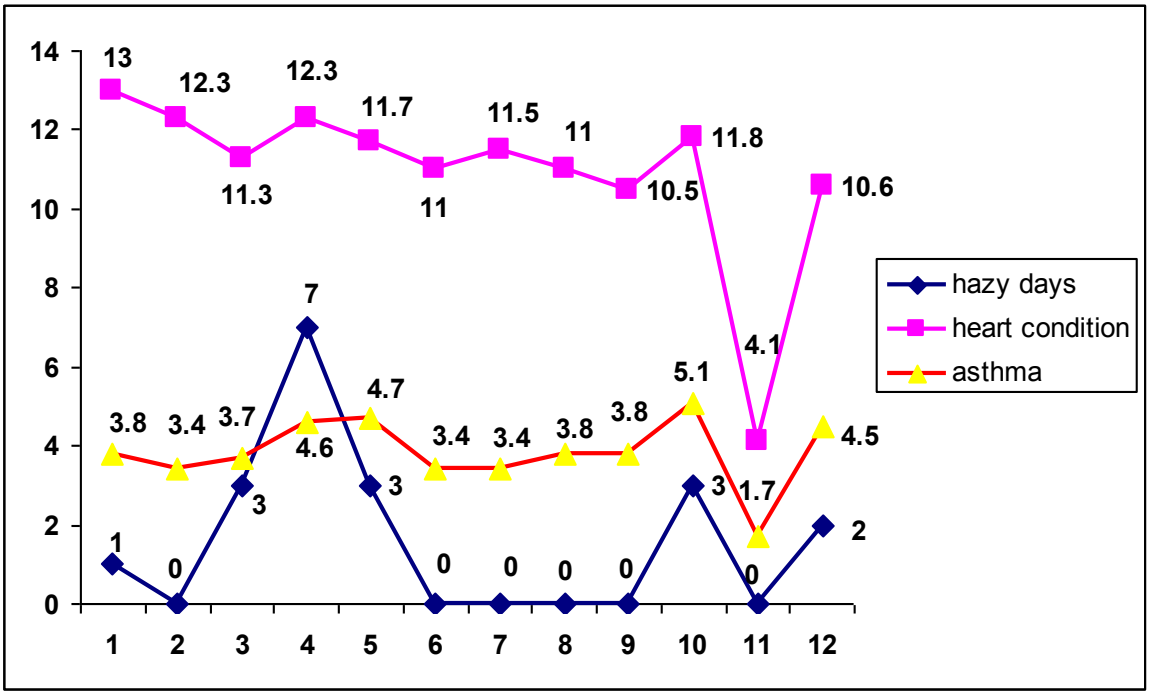


Fig. (107): Heart condition cases (unit= 100) and asthma cases (unit= 100) recorded monthly in (MOH) health centers in Damascus matched to hazy days in 2003

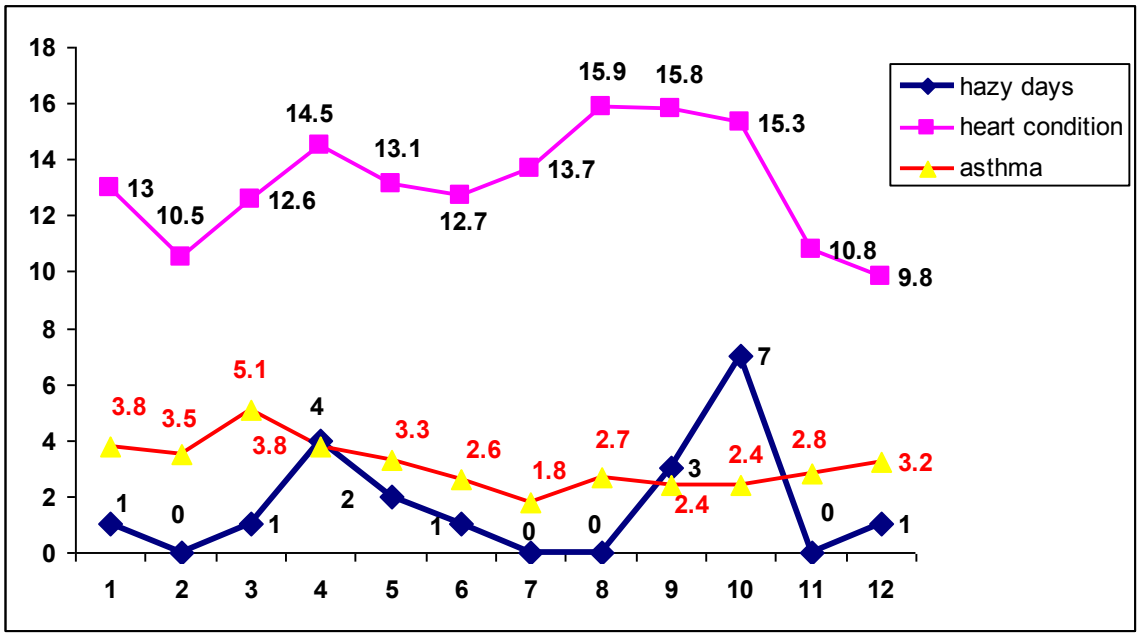


Fig. (108): Heart condition cases (unit= 100) and asthma cases (unit= 100) recorded monthly in (MOH) health centers in Damascus matched to hazy days in 2004

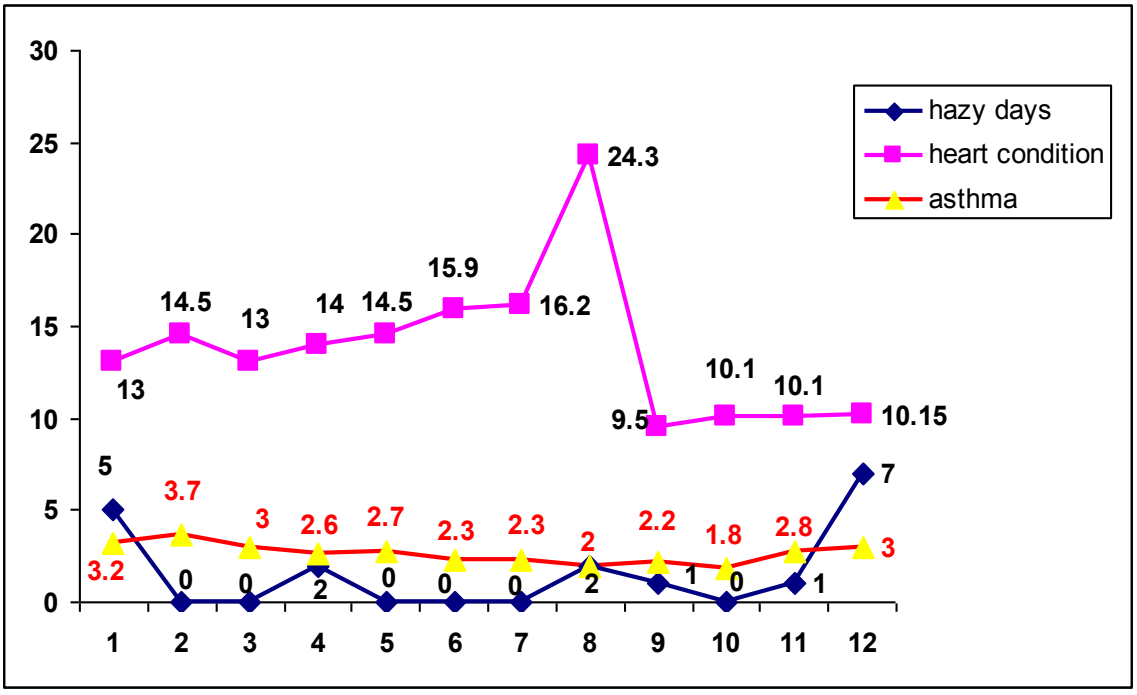


Fig. (109): Heart condition cases (unit= 100) and asthma cases (unit= 100) recorded monthly in (MOH) health centers in Damascus matched to hazy days in 2005

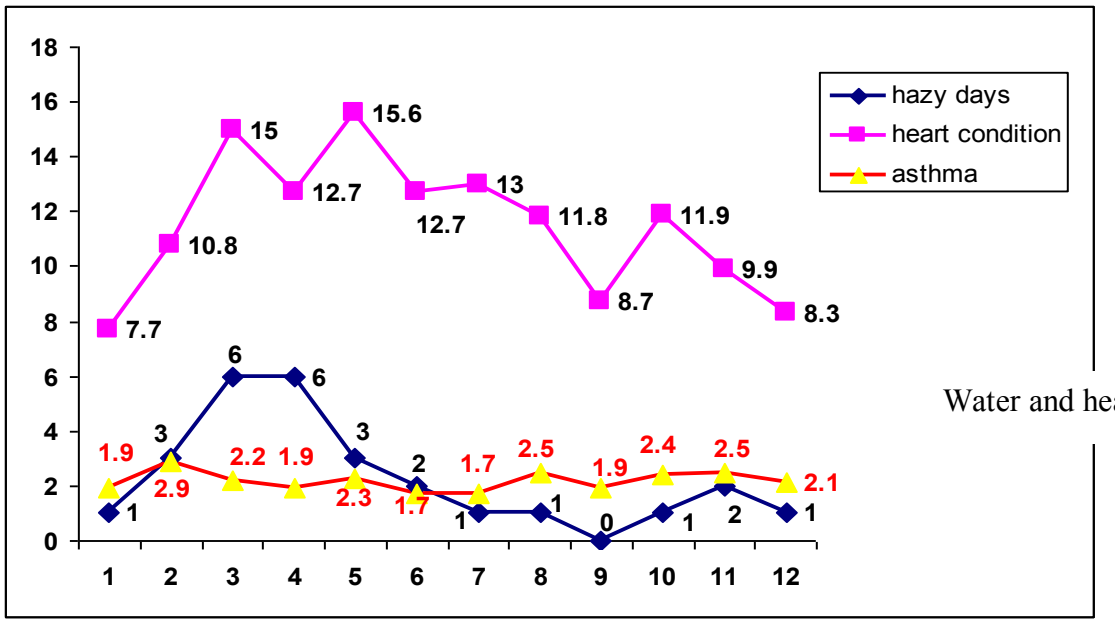


Fig. (110): Heart condition cases (unit=100) and asthma cases (unit=100) recorded monthly in (MOH) health centers in Damascus matched to hazy days in 2006

7.5. Extreme Weather Events

Floods: Floods and their health impact were studied as a feature that could be the result of certain causes related to climate change, especially during extreme events such as rainy storms. Severe rainy storms lead very high quantity of rainfall sweeping on land surfaces with no drainage. In such cases, wastewater will mix with drinking water particularly if sewage pipes networks are incompetent. What causes further deterioration is the presence of garbage piles that are carried by water spreading environmental pollution and communicable diseases. Floods usually carry two types of health problems:

- Direct health problem such as mortality, drifting, drowning, and slipping during flood peak.
- Lagging indirect health problems; such as the pollution affecting water and food, which lead to the spread of waterborne and food born diseases. Furthermore, new focus of vector borne diseases (like malaria) may appear in case the flood leaves some swamps, with the disadvantage of having the disease reservoir present (in these case human beings).

In order to have a comprehensive knowledge of most potential flood health impact It is of utmost importance to search for socioeconomic implications, and problems resulting of homelessness, loosing shelter, loss of foods, land drifting, loss of crops, and loss of livestock. These consequences exhaust the capacities of affected families physically and psychologically leading to general deterioration of health status.

Fig. (111) illustrates some direct consequences[xxiii] of the health effects of *Zaizoon* dam breakdown in Hama governorate in 2002. That breakdown affected *Hama* and *Idleb* governorates (Hama losses only are shown).

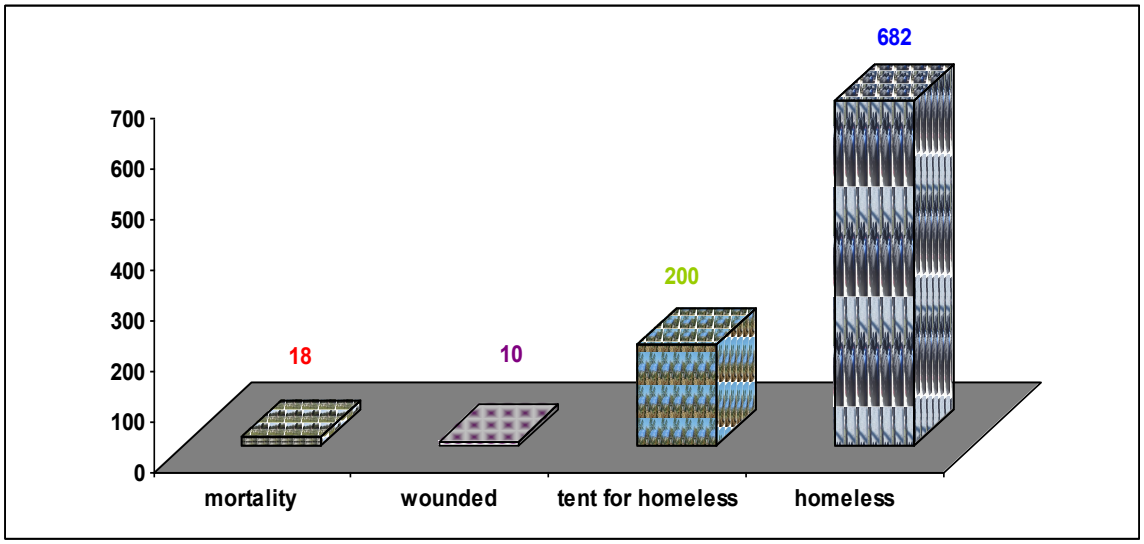


Fig. (111): Some direct health results of *Zaizoon* dam breakdown in 2002

Figure (112) illustrates consequences of the floods happened in *Kamishlee* district (*Hasaka* governorate) following heavy rainfall in 2006.

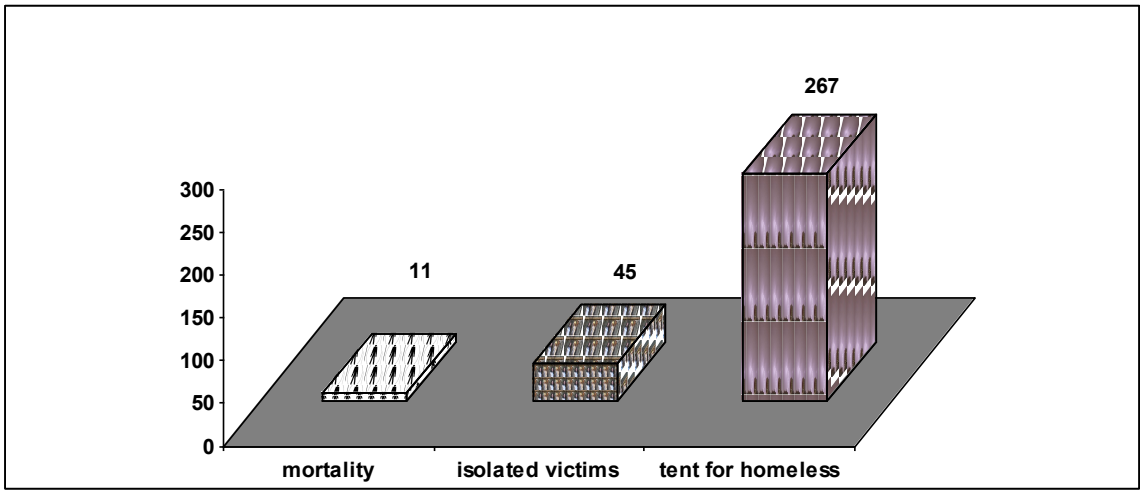


Fig. (112): Some consequencesxxiv of *Kamishlee* flood in 2006

The review of all available documents on these floods revealed lack of accurate statistics regarding number of homeless or of medical casualties following the events. Reports then focused on describing implemented activities such as moving medical teams, civil defense teams, and engineering equipments. As for health casualties, they were not presented in details or in a satisfactory way. Hence the extreme difficulty encountered in having a good conception describing the indirect health impact of these extreme weather events becomes justified.

7.6. Drinking water pollution and its health impact

Health effects of two separate events (in two different governorates) of drinking water pollution were studied regardless of causes. Water pollution in both cases started an epidemic of viral hepatitis type A. Cases number surpassed 100 cases[xxv] in the pollution that occurred in *Salamiah* (Hama governorate) in 2007, and 200[xxvi] cases in the pollution that occurred in Katana (Rural Damascus governorate) in 2008.

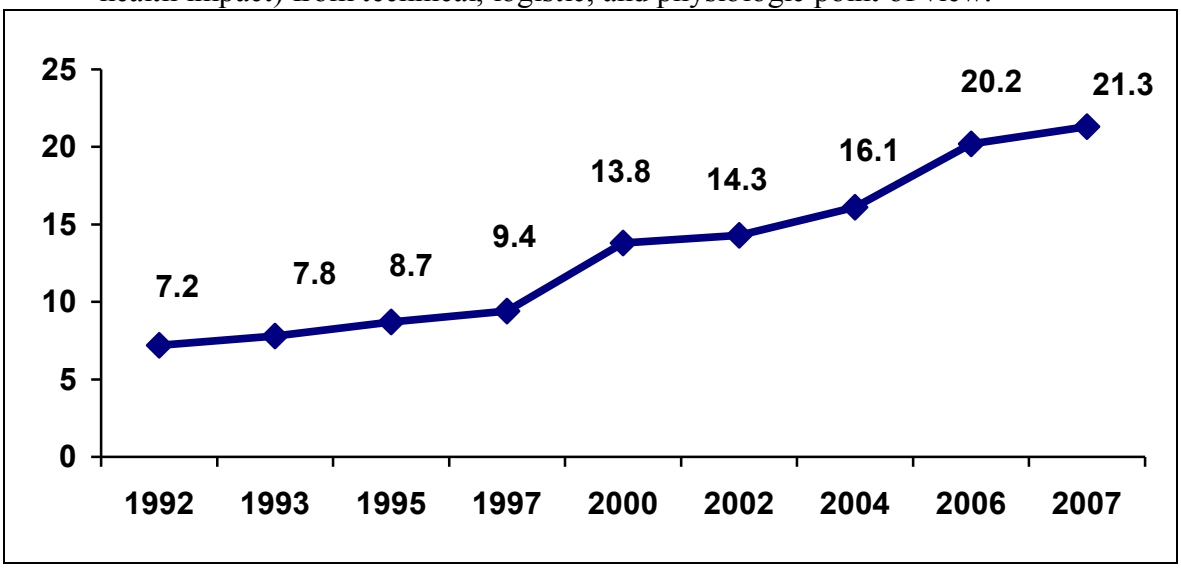
It is well known that viral hepatitis A is not the only disease that spreads by means of water pollution. More gastro enteric diseases are waterborne including diarrhea and typhoid fever. Therefore, one cannot overemphasizes the importance of observing and studying

both direct and indirect health consequences arising from drinking v Water and health same concept applies on food pollution as well; since such pollution is expected in the context of extreme events resulting from climate change (preserving and storing foods in high temperature weather rendering them more vulnerable to be spoiled). This situation allows for more cases of food poisoning and gastrointestinal diseases. Extremely hot weather calls for more use of air conditions leading to power interruption. Such interruption increases the risk of food spoiling especially those preserved in refrigerators or by freezing.

8. Results and discussion

Having analyzed the available data from 1991 to 2007 that could generate a relationship linking climate change to its health impact, we came with the following results:

1. ***Climate change***: there is actually a real change in local temperature averages towards both end of the scale all over Syria. Extreme heat waves started as early as June in the following years: 2000, 2001 and 2006 (in Damascus where the weather is considered in the Syrian medium range). Extreme cold weather waves occurred more frequently (2000-2001 and 2005-2006). There are some predisposing factors for climate change that are locally signed:
   a. Concentration of population in big cities leading to increased pressure on services, mainly transportation, energy supply, and food.
   b. The huge rise in energy production and consumption leading to increased CO2 emissions (Fig. 113) considered as main component of green house gases causing global warming.
   c. The catastrophic increase in motor vehicles[xxvii] especially in crowded cities that were not adjusted to fit these big numbers. The result was more air pollution and temperature rising.
   d. There is maximum limit for adaptation (with prevention of direct and indirect health impact) from technical, logistic, and physiologic point of view.



2.

Fig. (113): CO_2 quantitiesxxviii (1000 tons) released by power station in Syria over 1992- 2007

2. ***Vector borne diseases***:
   a. *Leishmaniasis*: climate change has resulted in pattern modification of land use shifting from agriculture to pastoral type due to drought caused by tiny rainfall. This process caused loss of biodiversity (decreasing numbers of camels especially in Rural Damascus) creating a space for proliferation of certain plant, "*Anabasis Articulata*", ingested by rodents. These rodents, representing the

disease reservoir, have increased in numbers. At the same time, the numbers of rodent natural predator, hawks, has declined due to increased demand by Gulf countries. Furthermore, demographic changes, more urbanization and land use for housing approaching the rodent habitat, contributed to the spread of leishmaniasis in Rural Damascus governorate (*Dumayr* district). This same situation could be found in any similar setting (climate- environment-demographic changes) in other locations.

b. Malaria: the natural drought experienced in Syria along with artificial drying of many swamps and water surfaces have played a positive role in malaria retraction. However, reemerging of this disease cannot be overruled in case of heavy rainfall leaving exposed fresh water surfaces. This reemergence is determined by two factors: the first one is the presence of carrying mosquitoes, which is abounded in Syrian environment. The second one is the availability of reservoirs, any affected human, were efforts are focused to break the transmission chain.

c. *Shistosomiasis: Shistosomiasis* is the shadow of irrigation projects. Water dams and channels carry the risk of this disease reemerging under three conditions: availability of infected human, snails, and bad environmental behaviors. Thanks to transmission chain break on human level (not the lack of suitable environment), Syria now is free from *shistosomiasis*.

3. ***Syrian environment in general***: general environment is taken as non-specific index of environmental diseases. It does not provide us with accurate map of disease distribution. Therefore, data should be analyzed on governorate if not on city levels. Leishmaniasis in Aleppo, for instance, has some particularity featured in the emerging of cases in high altitude areas. Taking into account the old conception of disease restriction to low altitude, one cannot help wonder about the reason. The same situation applies on cutaneous leishmaniasis in *Lattakia* and *Tartous* governorates but with replacing altitude by relative humidity and the presence of unprecedented types of the vector (sand fly) in the Syrian epidemiological map. The very same situation applies to chronic diseases and how they are affected by temperature and weather conditions. Cities affected by heavy traffic– due to huge numbers of motor vehicles- are prone to high levels of air pollution, which increases mortality and morbidity attributed to respiratory illnesses- already under the influence of climate change-. Inhabitants of areas hit by sand storms and hazy weather conditions suffer in the same way.
4. ***Nutrition status***: despite the remarkable development in the agrarian sector, the malnutrition indices tend to increase in the under five children group (the most vulnerable group) according to five national surveys. Therefore, more detailed researches are needed to clarify the reasons for this phenomenon.
5. ***Diseases related to the quality of drinking water and irrigation water***: there was a clear inverted relationship between these diseases and the water per capita. The worse the quantity and quality of water, the higher the incidence of diarrhea and waterborne diseases. This was very prominent in Rural Damascus and Quneytra, and to less extent in Damascus itself. There was a trend towards slight increase in typhoid fever cases as the water per capita went down. The connection may well be deeper with the quality of water used for crop irrigation especially consumption of raw vegetables.
6. ***Extreme weather events****:* the study of two separate flood events, in two different locations and for different reasons revealed that damage loss included death, house demolishing, homelessness and shelter loss, drifting of part of agrarian land along

with its crops, livestock loss, and creating many superficial water surfaces. These factors represent environmental elements that carry very high risk of communicable disease spread and deterioration of chronic diseases situation. The psychological and socio-economical status of affected population plunged deeply in the aftermath of the flood, but unfortunately, not enough attention was given to obs[illegible] either event. The direct consequences only were dealt with.

Water and health

7. ***Environmental pollution***: two separate events of drinking water pollution were studied. The reason was mixing drinking water with wastewater. The clear direct result was the occurrence of viral hepatitis A epidemic in both cases, with no cases of typhoid fever. However, there was some typhoid spreading in previous events known to the team preparing this report, the cause was similar: wastewater gaining access to drinking water. As for air pollution, no data were available on extreme pollution events rendering them difficult to assess.

9. Recommendations

Enlisted below is the national strategy to prevent the negative health impact of climate change and the negative environmental impact in general, and mitigation principles*:*

1. Plans based on scientific studies are either:
   a. Field studies aiming to assess the diseases' current situation and focusing on environmental and climatic factors in order to set the stage for future surveillance.
   b. Statistics analytics' studies dealing with available data and information on the longest possible period. Data sources should include health sector and other relevant sectors. The analysis target is to find cross-sections and establish relations. The aim of such studies is to create a database that represents baseline for further studies.

      Many requirements are needed for these studies to become a success. The first condition is data validity; the issue that was not as solid in the data provided for this report. The second one is insuring free access to data sources. Once again, it was not as easy to gain such freedom during this report work. The third one is related to the format of data or information that should allow for easy analysis; that issue was not available in data presented to this report.
2. Fruitful cooperation among different sectors: that denotes understanding the close relation between all kind of implemented activities and involved parties with health outcomes resulting from such activities. Every human action is connected to health status whether directly or indirectly. It is very important to cooperate not only with governmental institutions, but also with non-governmental ones as well. Requirements for such fruitful cooperation include:
   a. Availability of highly validated scientific approaches to implement climate change surveillance and documentation.
   b. Open channels to exchange information.
   c. Feedback to various involved parties.
   d. Partnership and coordination regarding already designed work plans.
3. Sophisticated cooperation among countries on regional and global levels: since most health impact of climate change has trans-border nature, a full cooperation is required to implement integrated plans. A representative example of this conception is the pollution of an international river or breakdown of water dam in one country with consequences affecting neighboring countries. A he cross-border fire is another example. Health impact of those extreme events are not restricted to the country of

origin but can be extended to far distances. Oil wells burning in Kuwait during the second gulf war affected other faraway countries.

4. Counseling regarding delicate technical issues with international organizations working in research fields especially the WHO and the UNDP (United Nation Development Program). The issues targeted by this counseling should include choosing the most sensible and valid indices to evaluate surveillance systems and networks, and choosing indices of early warning and other technical and health indicators.
5. Making sustained environment friendly development a priority, i.e. development that consider public health and respect human dignity as a pathway to future.

9.1. Adaption strategy in health sector

Health sector needs extensive work to deal with health impact of climate change. Issues on stake would include:

- ✓ Validity of routinely collected information through information systems. That would include writing the disease correct diagnosis in the records, keeping records for as many years as possible, electronic version of records, and easy access to these records any time. This is true for hospitals, health centers, and health units.
- ✓ Validity of death records regarding direct and indirect causes. Many death certificates- if not most of them- were found to be inaccurate. This has given hard time when trying to link climate change to death causes. Therefore, we need to train physicians and promote them to describe the real cause of death.
- ✓ Involve all the parties working in health services including private sector in a cooperation program. This program is expected to provide necessary information to monitor modifications of potential health impact of climate change. It is well known that private sector provides about 50 % of health services in Syria. The Ministry of High Education and the Ministry of Defense should be involved as well.
- ✓ Adopting WHO indicators and standards on national level in case no national matches- built on national policy basis- are available. Strengthening relation with (WHO) and other international research organizations.
- ✓ Preserving ongoing prevention programs regarding some climate related diseases despite the persistent improvement in their situation. These diseases keep to be a risk source enhanced by climate change owing to the close relation between them. Examples would include diarrhea, malaria, leishmaniasis, and *shistosomiasis*.
- ✓ Starting a new program in the Environmental Health Department in the (MOH) to deal with health impact of climate change, and providing required support such as staff training, logistics, and financing.
- ✓ Promoting and supporting health services and training health workers on how to deal with health impact of climate change.
- ✓ Providing additional budgets to set a network to monitor and evaluate diseases related to climate change.

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