CHAPTER I
INTRODUCTION

1.1 Environmental radioactivity

The presence of radionuclides in different environmental compartment in principal, due to naturally occurring or man made. In naturally occurring, radionuclides originate from extraterrestrial source as well as radioactive elements in earth crust. Several isotopes present in natural, whether singly occurring nuclides as K-40, V-50, Rb-87, In-115 which decay directly to a stable nuclides or they are occur in chain radioactive series as uranium series (U-238), thorium series (Th-232) and actinium series (U-235) which have the final product of lead. The fourth series, which is artificial, is the neptunium series. Our studies are concerned with natural decay series. In absence of chemical process each of three series reached to secular equilibrium. Fig (1-1) illustrates the decay schemes of naturally occurring radioactive elements. The most important singly radionuclides are K-40, Rb-87 with abundance 0.118 % and 27.85 % respectively. Although K-40 has lower abundance than Rb-87, K-40 is more abundant in earth crust (1). On the other hand, the man made release of radionuclides in environment have several sources (2), including normal operation of nuclear fuel cycle facilities, atmospheric testing of nuclear weapon which release large amount of fission products and substantial amounts of radionuclides such as C-14, H-3 also, krypton-85, Iodine-129. They have been identified as the radionuclides mostly present in effluent resulting from fuel cycle activities (3), where, atmospheric testing of nuclear weapon and major nuclear accidents are considered the main source of radionuclides released from nuclear fission. Table (1-1) gives a survey of these fission and activities products which may be concerned in human exposure. Mining and milling process for uranium production ore always coupled with radiation exposure risks due to the radon-222 ($t^{1/2}$ 3.83 d) emanation and particulate dispersion. The radionuclides contained in uranium ores include primarily uranium-238 and its radioactive decay

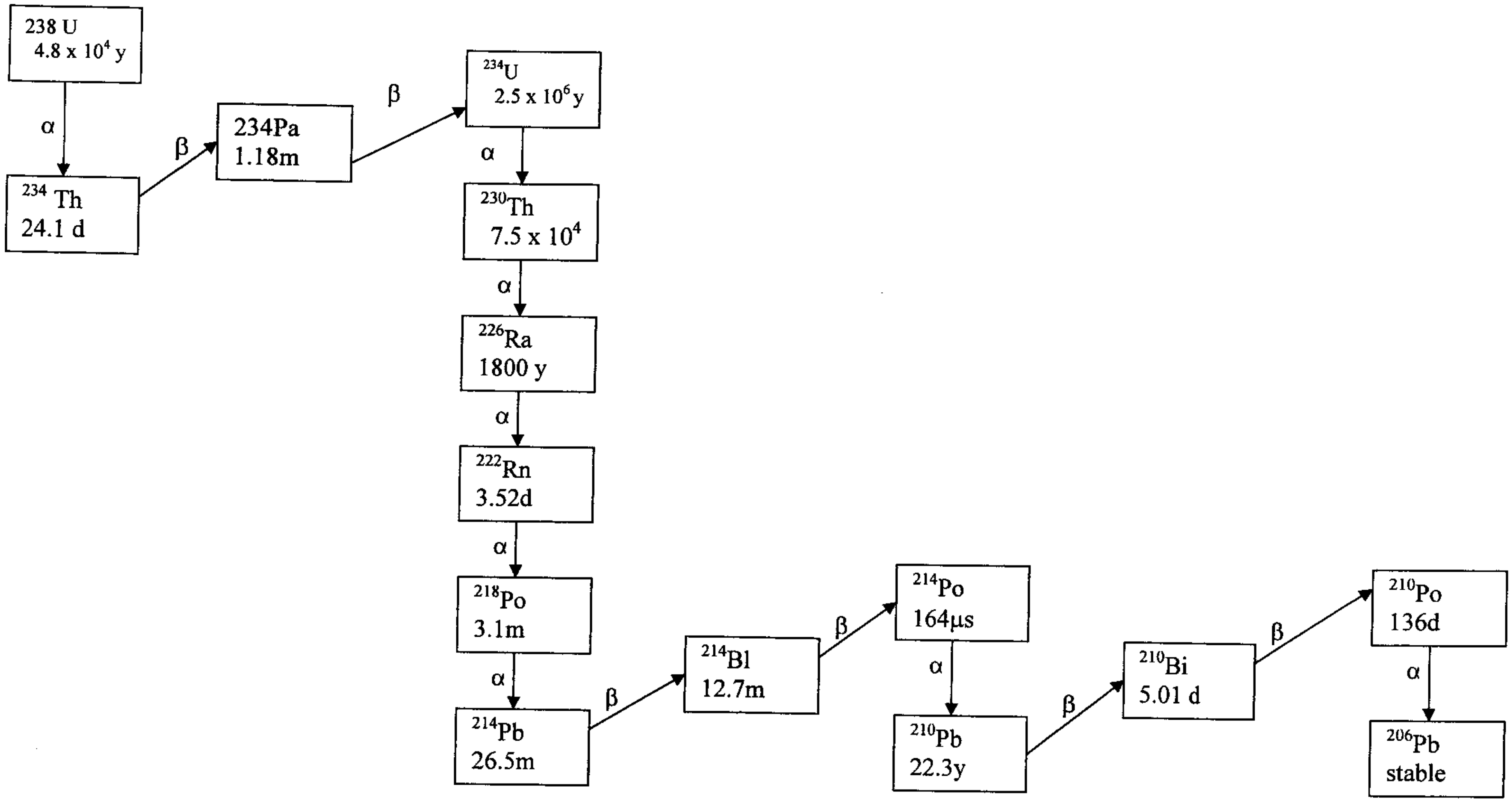

Fig.(1-1-A) uranium-238 series

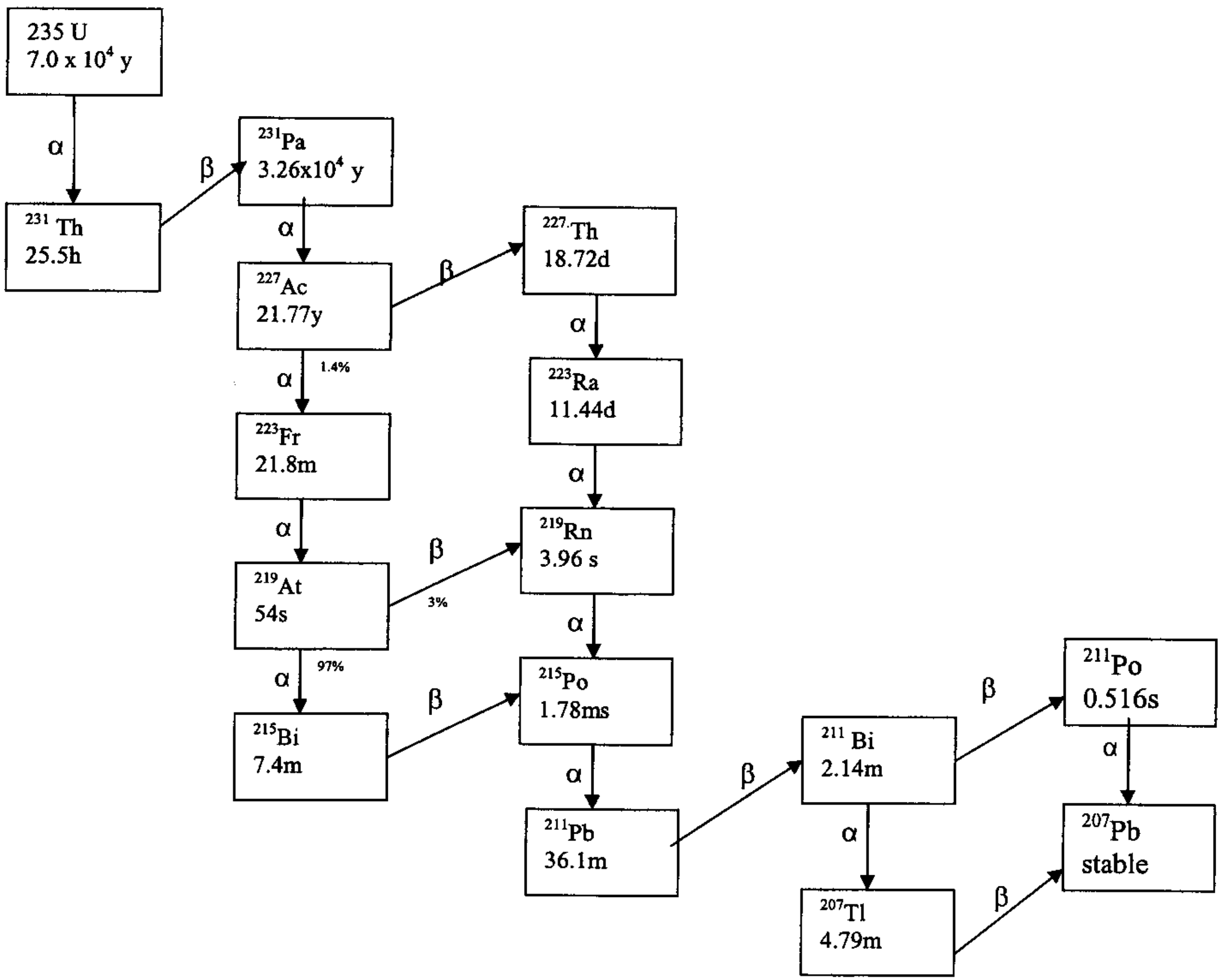

Fig.(1-1-B) uranium-235

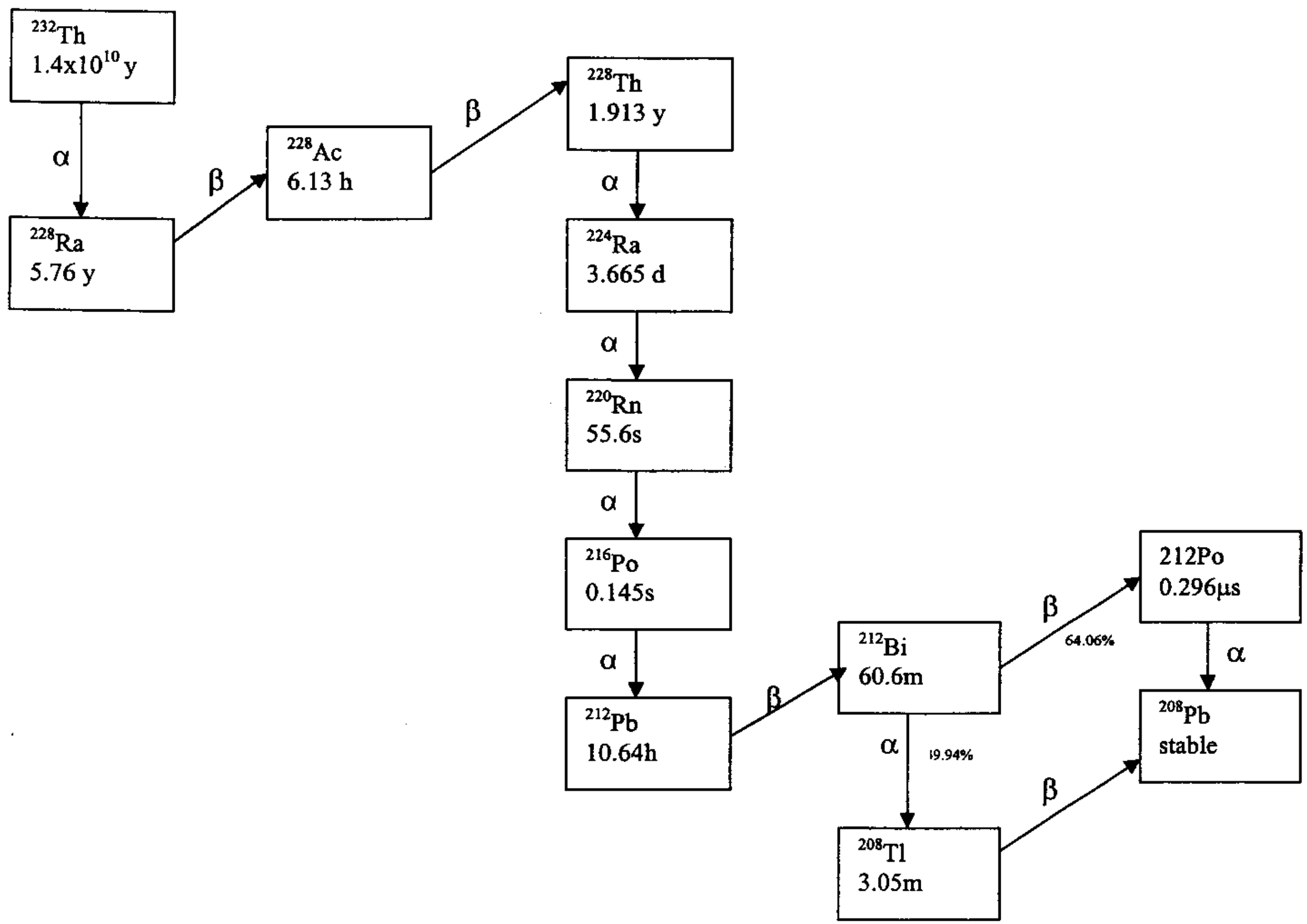

Fig. (1-1-C) Thorium-232 series

Table (1-1): fission and activation products which may be of concern in human exposure.

	Nuclide	Half-life	Fission yield %	Major decay
Fission Products	Sr-89	50.5 d	4.77	β^-
	Sr-90 , Y-90	28.7 a, 64.1 h	5.76	β^-,β^-
	Zr-95, Nb-95	64.09 d, 35.0 d	6.51	$\beta^-\gamma,\beta^-\gamma$
	Mo-99 , Tc-99m	2.747 d, 6.006 h	6.09	$\beta^-\gamma,\beta^-\gamma$
	Ru-103 , Rh-103m	39.272 d, 56, 116 min	3.03	$\beta^-\gamma,\beta^-\gamma$
	Ru-106, Rh-106	372.6 d, 29.92 s	0.4	$\beta^-\gamma,\beta^-\gamma$
	Te-129m	33.6 d	0.661	$\beta^-\gamma$
	I-131	8.021 d	2.875	$\beta^-\gamma$
	Te-132 , I-132	76.856 h, 2.3 h	4.282	$\beta^-\gamma,\beta^-\gamma$
	Cs-137, Ba-137m	30.0 a, 2.55 min	6.136	β^-,γ
	Ba-140 , La-140	12.751 d, 1.6779 d	6.134	$\beta^-\gamma,\beta^-\gamma$
	Ce-144 , Pr-144	284.45 d, 17.28 d	5.443	$\beta^-\gamma,\beta^-\gamma$
Activation Products	H-3	12.35 a		β^-
	C14	5730 a		β^-
	Fe-55	2.75 a		EC
	Fe-59	44.53 d		$\beta^-\gamma$
	Mn-54	312.5 d		EC,γ
	Co-60	5.27 a		$\beta^-\gamma$
	Zn-65	243.9 d		EC,γ
	Cs-134	754.2 d		$\beta^-\gamma$
	Np-239	2.355 d		$\beta^-\gamma$
	Pu-241, Am241	14.35 a, 432.0 a		$\beta^-\gamma,\alpha\gamma$
	Cm-242	162.94 d		α
	Pu-238	87.7 a		α
	Pu-239	2.411×10^4 a		α
	Pu-240	6.563×10^3 a		α
	Pu-242	3.735×10^5 a		α

Half-life is given in minutes (min), hours (h), days (d) and years (a). One year = 365.25 days.

products including thorium-230 and radium-226 which decay to radon-222. In underground mining, radiological exposure is expected from the accumulation of radon-222 and its radioactive decay products in the surrounding atmosphere. In thorium mining is surface operation, inhalation hazards are relatively smaller compared to underground uranium mining where the man hazard is due to thoron (^{220}Rn) and the ore dust. The other sources of man made are accelerators, radioactive waste disposal site which should be to limit the released of radioactivity to the surrounding environment to be as low as reasonably achievable (ALARA). Present work is concerning about ^{226}Ra, ^{232}Th, ^{40}K and ^{137}Cs, to estimate the possible radiological hazards to human health, where, considerable attention in the last two decades to low exposure arising from a member of the uranium and thorium decays chains and ^{40}K in soils.

Ra-226 is a member of U-238 natural decay series and is the most hazardous r adionuclide r eleased to environment from u ranium mining and milling. Due to its long half life (1600years) and radiological effects where Ra-226 is one of the most important isotopes to be determined among the naturally occurring nuclides in environmental samples. It is also, the most toxic long-lived alpha emitter present in environmental samples, as well as one of the most widespread. The requirement for determination of radium has become a matter of interest in public health due to its hazardous nature with respect to internal exposure. It is concentrated in bones, this increasing internal radiation dose of individuals. Radium is relatively readily taken up by plants in comparison with uranium and thorium. Under normal environmental conditions about 90 % of ^{226}Ra enters the human body through food (4).

Potassium-40 is one of the most import radionuclides exist in all form of life. It can be transported through the food chain and finally to the human being. It is usually contributes around 90 % of the total beta/gamma content of foodstuffs (5)

Cesium-137 is one of the long-lived artificial radionuclides deposited on soil and transfer to plant then to the human, it has potential risk to human health. Several factors controlled for transfer Cesium-137 from soil to plants such as concentration ratio of its ions in soil to plants, clay mineral compostion, moisture, pH of soil as well as, plant stage of growth,.(6)

1-2 Previous studies

Several studies have been carried out to monitor the natural occurring nuclides in different environmental compartments to assess the pathways and to be awareness of importance of human exposures of natural radiation.

Skwarzec et al. (7). Determined the concentration of U-234 and U-238 and calculated the activity in waters and sediments from various region of the southern Baltic sea Gransk deep, Slupsk narrow and borehole deep. Where, the concentration of uranium in analyzed sediments from southern Baltic increase with core depth to what probably is connected with diffusion from sediments to water through interstitial water, where uranium concentration is much higher than in bottom water.

Balakrishna, et al. (8) has been made the distribution of U-238, U-234, Th-232 in soil, water, suspended particulate matter (SPM) and bottom sediments in the Kali river basin around Kiga, to obtain the baseline data of U-Th series nuclides in view of the commissioning of nuclear power reactor at Kiga, southern Coast of India

Ibrahiem et al.(9) had been studied the activities of U-238, Th-232, K-40 in Nile Delta, North Coast and middle Egypt Rregions. The average specific activities of 16.6, 18.1, and 316 Bq/Kg dry weight respectively. The lowest activity concentrations of these radionuclides were found in sandy soil.

El Tahawy et al, (10) studied the concentration of U-238, Th-232, K-40, Cs-137, in lake Naser, the concentration about of 13.5, 14, 90 and 0.72 Bq/Kg dry weight respectively. The data obtained from Asyut to Aswan indicated that the average activity concentration of U-238, Th-232, K-40 and Cs-137 were 17.2, 17.8, 307 and 0.95 Bq/Kg dry weight. The analysis of Alfalfa samples showed that U-238, Th-232 and K-40 and Cs-137 activities were 8.0, 9.1, 1537 and 9.7 Bq/Kg respectively.

Papachristodoulous et al. (11) used gamma ray spectrometry to determine uranium activity in soil samples collected from camping sites of

Greek expeditionary force in Kosovo. Assessment of U-238 concentration was based on measurements of the 63.3 KeV and 92.28 KeV emissions of its first daughter nuclides, Th-234. To determine the isotopic ratio of U-238/U-235, secular equilibrium along the two radioactive series was first ensured and thereby the contribution of U-235 under the 186 KeV peak was deduced. The uranium activity in sample varies from 48 to 112 $Bq/Kg.^{-1}$

Santos et al.,(12) reported that the concentration of naturally occurring radionuclides, Th-232, U-238, Pb-210, Ra-226 and Ra-228 in vegetable and derived product in Rio de Janerio, where, the estimated daily intakes due to consumption of vegetables and derived products were 1.9 mBq of Th-232 (0.47 μgm) 2.0 mBq of U-238 (0.17 μgm), 19 mBq of Ra-226, 26 mBq of Pb-212 and 47 mBq of Ra-228. The estimated annual affective dose due to the ingestion of vegetables and their derived products with long lived natural radionuclides is 14.5 μSv.

Techossa, et al., (13) reported the average concentration of radionuclides U-238, Th-232 series and K-40 in various of community water supplies of Osum state, Nigiria. The average specific activity values obtained for Ra-226, Ra-228 and K-40 respectively, were 8.67±4.28, 2.31 ± 1.48 and 98.99 ±6.23 Bql^{-1} for well water, 2.47 ±0.09 and 85.06 ± 17.27 Bq^{-1} for tap water, 10.40 ±1.70, 2.70±1.30 and 72.60 ±9.10 Bq l^{-1} for dam water, 7.04 ±0.66, 3.55±0.13 and 69.18 ±20.80 $Bql^{-1}$for stream water.

Selvasekarapandian et al.(14) determined the concentration of primordial radionuclides in soil sample of Gudalore district. The mean activities of Th-232, U-238 and K-40 were 75.3±44.1, 37.2±10.1 and 195.2±85.1 $Bqkg^{-1}$dry weigh respectively. The average outdoor absorbed dose rate in air at a height of 1 m above ground is 74.3±27.8 $nGyh^{-1}$, corresponding to annual affective dose equivalent of 455.6 μSv. The dose equivalent ranges from 168.3 to 125.50 μSv.

Vera Tome et al.(15) determined the activity concentrations of natural uranium isotopes (U-238 and U-234), thorium isotopes (Th-232, Th-230 and Th-228) and Ra-226 in soil and vegetation samples from disused uranium mine in South West Spain. The activity concentration mean value in affected zone by Bq/Kg were 10924, 10900 10075and 5289 for U-238, U-234, Th-230 and Ra-226 respectively in soil samples and 1050, 1060, 768 and 1141 Bq/Kg for the same radionuclides in plant samples. In unaffected zone the activity concentration values were 184, 190, 234 and 7251 Bq/Kg for U-238U-234, Th-230 and Ra-226 respectively in soil samples and 28, 29, 31, 80 Bq/Kg in plant samples.

YU et al.(16) determined the natural radionuclides U-238, Ra-226, Th-232 and K-40 in commonly consumed drinks in Hong Kong, including milk, water and soft drinks using low background gamma ray spectrometry and HPGE detector. The results showed that contribution from natural radionuclides in drinks with weighted dose equivalent is about three orders of magnitude higher than from Cs-137.

Fasasi et al. (17) used gamma spectrometry to determine the presence and level of radioactivity of radionuclide in bituminous sand and over burden obtained from bituminous sand deposits Ondo State Nigiria for the purpose of providing baseline data and assessing its impact on environment. The radionuclides identified with reliable regularity belong to the decay series of naturally occurring U-238, Th-232 series and K-40. The average specific activity concentration values obtained for Bi-214, Tl-208 and Ra-226 in the overburden were 165.64±2.91, 150.25±2.91 and 60.97±2.27 $Bqkg^{-1}$, respectively.

El-Bahi et al. (18) used HPGe detector to measure natural radioactive decay series (U-238, Th-232) and K-40 in different salts samples collected from old sediments in the Western desert at El Harra and Ain Giffara, Sitra lake and local market in Egypt. The activity of U-238, Th-232 and K-40 hase been determined in Bq/Kg dry weigh. The absorbed dose rate of gamma radiation was estimated to be 1.46-16.3 nGy/h.

Hakam et al. (19) were reported (U-238, Ra-226 and Ra-228 activities, U-234/U-238, Ra-228/Ra-226 and Ra-226/U-238 activities ratios) for natural water samples collected from wells, hot minerals springs, rivers, Tap water, lakes and irrigation water in Morocco. The results showed that U-238 activities varies between 4.5 and 309 $mBql^{-1}$in wells, and 0.6 and 8.5 $mBql^{-1}$

in hot spring, 9.7 and 28 $mBql^{-1}$in rivers, 2.5 and 16 $mBql^{-1}$ in tap waters and between 6 and 24 $mBql^{-1}$ in lakes.

Ahmed et al. (20) measured the concentration of natural radionuclides Ra-226 and Th-232 in ground and drinking water of some areas in upper Egypt by gamma ray spectrometry. The results showed a difference in radioactivity contents depending on their origin and place. Where the activities in pCi/l for Ra-226 and Th-232 in Qena (tap water) are 1.32±0.7, 0.74 ±0.44, for Sfaga and Qusier (tap water) 1.52±0.77, 0.79±0.45 respectively and for open artizian wells in Qena governorate 2.14±0.78, 1.1±0.62 and open wells in Safaga and Qusier 2.82±0.9 and 1.53±0.6 respectively.

Abbady et al (21) measured γ-ray activities of igneous and metamorphic rocks from Egypt and Germany due to naturally occurring, potentially hazardous radonuclides ^{226}Ra, and ^{232}Th and ^{40}K. The radiation hazard parameters including radiation equivalent activity, gamma-absorbed dose rate, and external and internal hazard indices have been estimated. The gamma-absorbed dose rates in air of rocks in Egypt range from 4.2 to 128.5 $nGyh^{-1}$ with a mean value of 55.3 $nGyh^{-1}$. For igneous and metamorphic rocks from Gemany, the values of absorbed dose rates fluctuate from 5.1 to 148.6 $nGyh^{-1}$ with a mean value of 60.9 $nGyh^{-1}$. Generally, it is found that the radiation hazard indices in common igneous rocks are distinctly higher in acidic than in ultrabasic rocks.

.El Tahawy et al.(22) measured concentration of natural and artificial radionuclides in Suez Cannal using gamma spectrometer. The activity concentration of U-238 series, Th-232 series and K-40 did not exceeded 16.0, 15.5 and 500 $Bqkg^{-1}$dry weight for sediments and the activity concentration of U-238and K-40 did not exceeded 0.6 and 18 $Bql^{-1}$for stream water.

Papastefanou et al. (23) measured of fall out derived Cs-137 and naturally occurring radionuclides such as K-40 and Be-7 in soil and grass area of northern Greece in 11 years period. The activity showed Cs-137 range from 3.73 to 1307 $Bqkg^{-1}$(average 210.5) in soil and from 0.4 to 334.9 $Bqkg^{-1}$ (average 14.5) in grass. K-40 concentration ranged from 141.4 to 580.2 $Bqkg^{-1}$ (average 224.4) in soil and from 66.3 to 1480 Bq kg^{-1} (average

399.8) in grass. Beryllium-7 concentration range from 0.53 to 39.6 Bq kg^{-1} (average 14.4) in soil and from 2.1 to 348 Bq kg^{-1} (average 54.4) in grass.

Peter Bossew et al. (24) determined natural radionuclides K-40, Ra-226 in the surrounding of Bilibino, Chukotka, Russia for different environmental compartments including; sediment, soil, lichens, mosses and reindeer meat and bones in 1994. The activities for K-40, Ra-226, Ra-228 were 564 ±15%, 29 ±32%, and 33 ±25% respectively in dry soil samples. The highest plant concentrations were found in mosses and lichens , with Cs-137 up to 75 and 46 Bqkg-1 respectively, in remote areas, and 91 and 103 $Bqkg^{-1}$respectively, in vicinity of Bilibino nuclear power plant.

Saqan et al. (25) Measured the natural radioactivity isotopes in hot mineral water. The measured radionuclides were Th-234, Ra-226, Pb-214, Bi-214, Ac-228, Th-228, Pb-212, Bi-212 and Tl 208. The activities range from 0.14 to 34.8 Bq/l, while concentrations of parent uranium and thorium isotopes ranged from $3x10^{-3}$ to 0.59 mg/l.

Yoshimura et al. (26) reported that the gamma ray contribution to the ambient dose rate in city of Sao Paulo, Brazil, measurements were taken at 1 m from the ground, outdoors and indoor, also the ambient dose equivalent were assessed. It was found that in average the indoor dose rate are 46% higher than the outdoor values. No statistically significant cluster of dose value was found in the distribution of outdoor values over city territory.

Karunakara et al. (27) determined the activity concentration of Ra-226, K-40 and Be concentration in leaves, stem and bark samples from several plant species which were collected from tropical forest of Kariga, in the west coast of India where two nuclear power reactors of 220 Mw each have just been commissioned and another two are under construction. The results showed that the activity of Ra-226, K-40 in plants vary in the range BDL-13.2 and 12.0-797.3 Bq/Kg^{-1}, respectively. Plants showed significant Be activity in leaves, the activity varied in 72.5-1060.8 $BqKg^{-1}$. Stem and bark of plants showed higher levels of Ra-226 and K-40 when compared to leaves. Soil to plant transfer factor for Ra-226 and K-40 were found to vary in the range BDL-0.37 and 0.09-5.61, respectively for different plants. The concentration of Ra-226 and K-40 in leaves depends on the age of leaves.

1.3 Potential pathways to the man

The dispersion of radionuclides in environment is mainly by two ways; the first one; by atmospheric dispersion and the second; by dispersion in liquid effluent (28). Fig (1-2) represents radiation exposure pathway to man. The exposure pathways to the man classified into two main categories as follow: (i) external exposure by direct exposure; immersion in water, submersion in air, surface contamination by radioactive fallout; (ii) internal exposure by inhalation in air containing radioactive gases or particulate; ingestion of food materials (e.g leafy vegetables, fish, etc) and water . Table (1-2), represents the radiological exposure pathway to man and its critical radionuclides, critical exposure pathways and critical organ.

1.3.1 Atmospheric dispersion of radioactivity

Atmospheric dispersion of gases or airborne radwastes are considered the most important factor for transport of radionuclides such as I-131, Cs-137, Sr-90 from nuclear facilities to environment. The radwastes have several impacts on environment whether by inhalation of air born contaminates or by deposition as well as, by adsorption on soils, plants and rivers bottom with subsequent movement and reconcentration of radioactivity through food chain. Fig. (1-3), illustrates the atmospheric release of radionuclides and its major pathways to man. Strontium and iodine deposition from airborne contamination and subsequently uptake in plants and crops grazing by cows and cattle's, and appearance in milk and milk products, also cesium –137 deposit on lichen and appearance in meat and milk products consumption by man. Generally the processes involve contamination of food chain are considered complex mechanism (29). The influence of atmospheric dispersion depend on several parameters including,

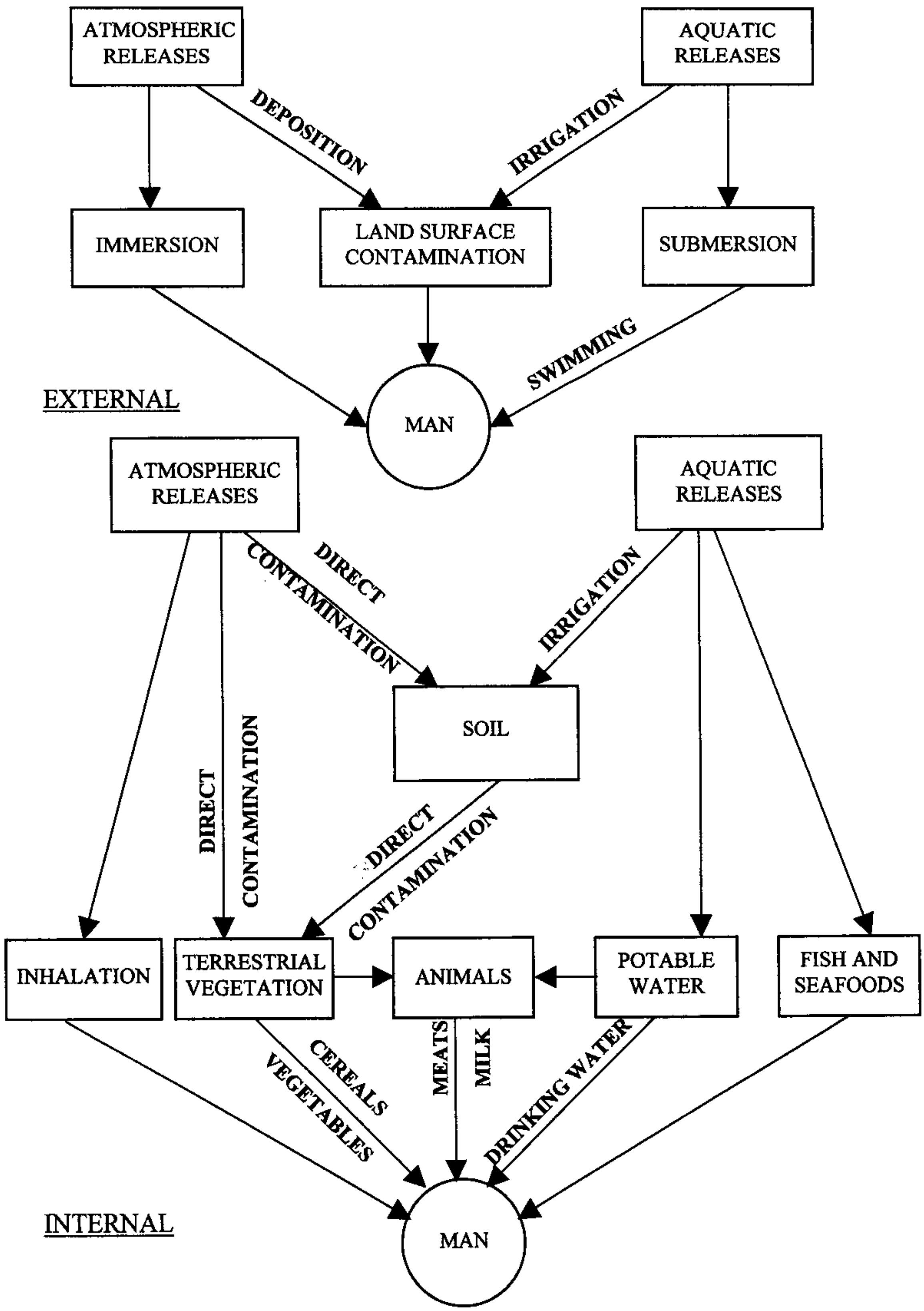

Fig. (1-2) pathways for external and internal radiation exposure of

Table (1-2): radiological exposure pathways *)

transfer mode	critical radionuclides	critical exposure pathways	critical organ
airborne	I-131, Cs-134, Cs-137, H-3, and radioisotopes of noble gases	air inhalation, ground deposition, leafy vegatables and grass -cow- milk	thyroid gland, skin, and whole body
water	H-3, I-131, Sr-89, Sr-90, Cs-134, Cs-137, radioisotopes of transi-tion metals (Fe,Co, Ni, Zn, Mn)	drinking water, fish consumption, shell fish, food consumption, and submersion	whole body, thyroid gland, GI tract
Milk	Sr-89, Sr-90, I-131, Cs-134 and Cs-137	grass -cow- milk and ingestion, of milk products	thyroid gland, whole body, GI tract
meat	Cs -134 and Cs-137	grass- meat	whole body, GI tract
other food	Sr-89, Sr-90, Cs-134 and Cs-137	fish consumption, consumption of vegetables and fruits	whole body, GI tract
vegetation	Sr-89, Sr-90, Zr-95, Nb-95, Ru-103, Ru-106. I-131, Cs-134, Cs-137, Ce-141 and Ce-144	grass-cow-milk, consumption of leafy vegetables and fruits	thyroid gland, whole body, GI tract
soil	Sr-90, Cs-134, Cs-137, Pu-238, Pu-239 + 240, Am-241 and Cm-242	ground deposition and external exposure	whole body

*) see International Atomic Energy Agency "Measurement of radionuclides in food and the environment". A Guide Book, Technical Report Series No. 295, IAEA, Vienna (1989),p.10 (64).

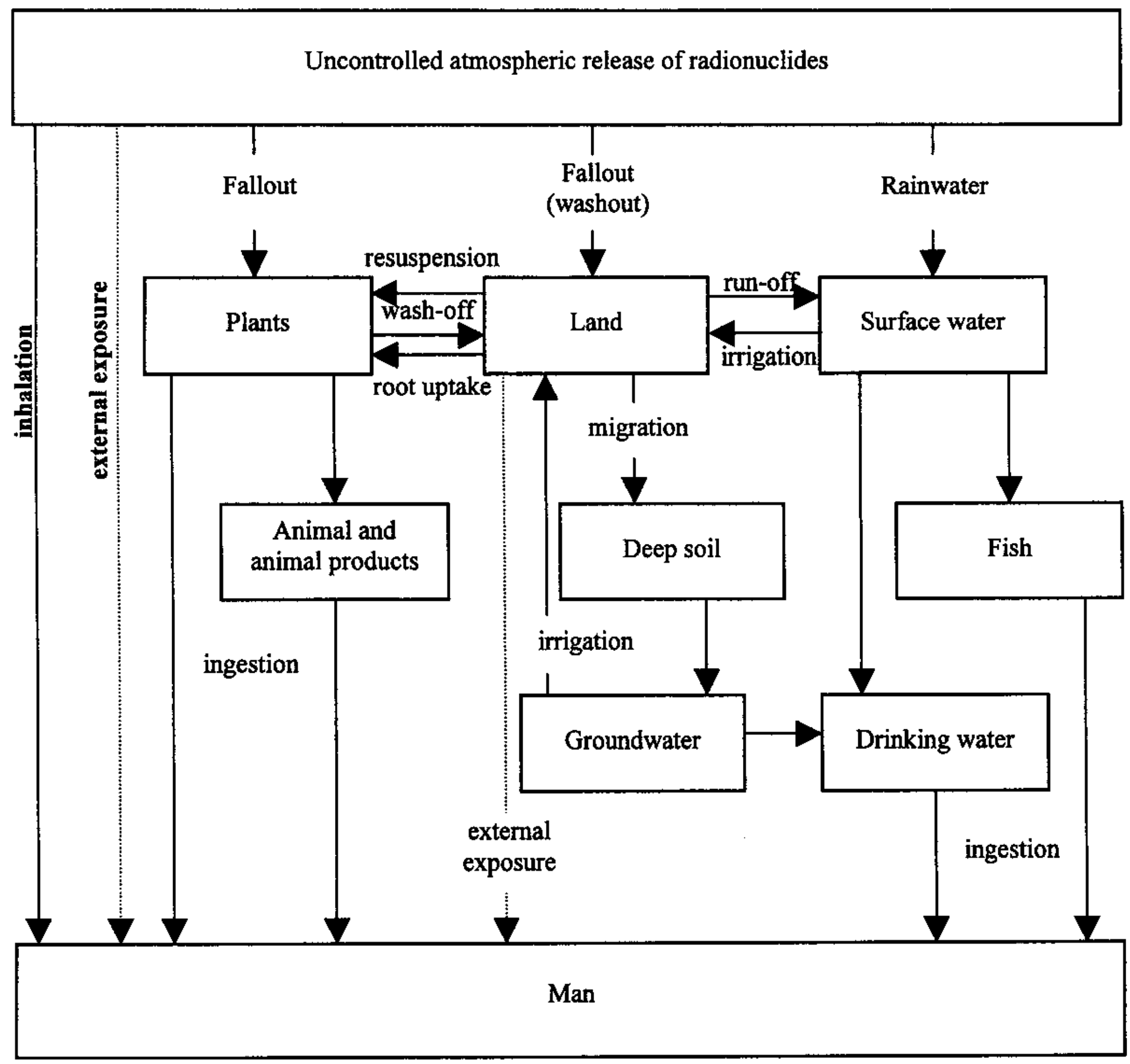

Fig.(1-3) atmospheric release of radionuclides and its major pathways to man speed and direction of wind, distance from release point, half life of radionuclides, source release rate (Ci/sec), the level of radioactivity concentration (Ci/m^3), and several other parameter should be taken in consideration for use an appropriate diffusion models for transport and dispersion of air borne materials. It is suitable to mention that, the air dispersion experiments were assessment in El Dabaa area as a result of cooperation between IAEA and NPPA in Egypt.

1.3.2 Liquid dispersion of radioactivity

Radionuclides released into liquid effluent are controlled by several factors as the rate of dilution, water volumes, depth of released point, the direction and movement of water and any possible reconcentration by sediment transport or organic residues.

Several parameter are considered in a complex models to study the influence of release on environment and to assess dose calculations which related to intake through drinking water at down stream locations and reconcentration of radionuclides in the food chain occurs by different types of fish, plankton, sea weeds, alga, etc. Sea foods mostly are the important source of exposure (30) and consider as an aquatic pathways to the population dose, where a certain radionuclides and trace element accumulate in bone and tissues by marine organism to man through consumption of fish and other marine animals. The radionuclides absorbed or ingested by phytoplankton, zooplankton which eaten by fish, amphibian, and by various macroinvertiberates such as crabs, lobsters and mollusks or absorbed directly by macrophytes, larger plants and pass to man via macroinvertebereates. The most convenient way to assess probable reconcentration of radionuclides in aquatic organisms is by means of the "biaccumulation factor Cf " which represents the ratio of the concentration of certain radionuclides in specific type of fish (expressed in pCi/kg) to its concentration in water (expressed in pCi/kg). Fig (1-4); represents the principal exposure pathway to man for radioactive liquid effluent.

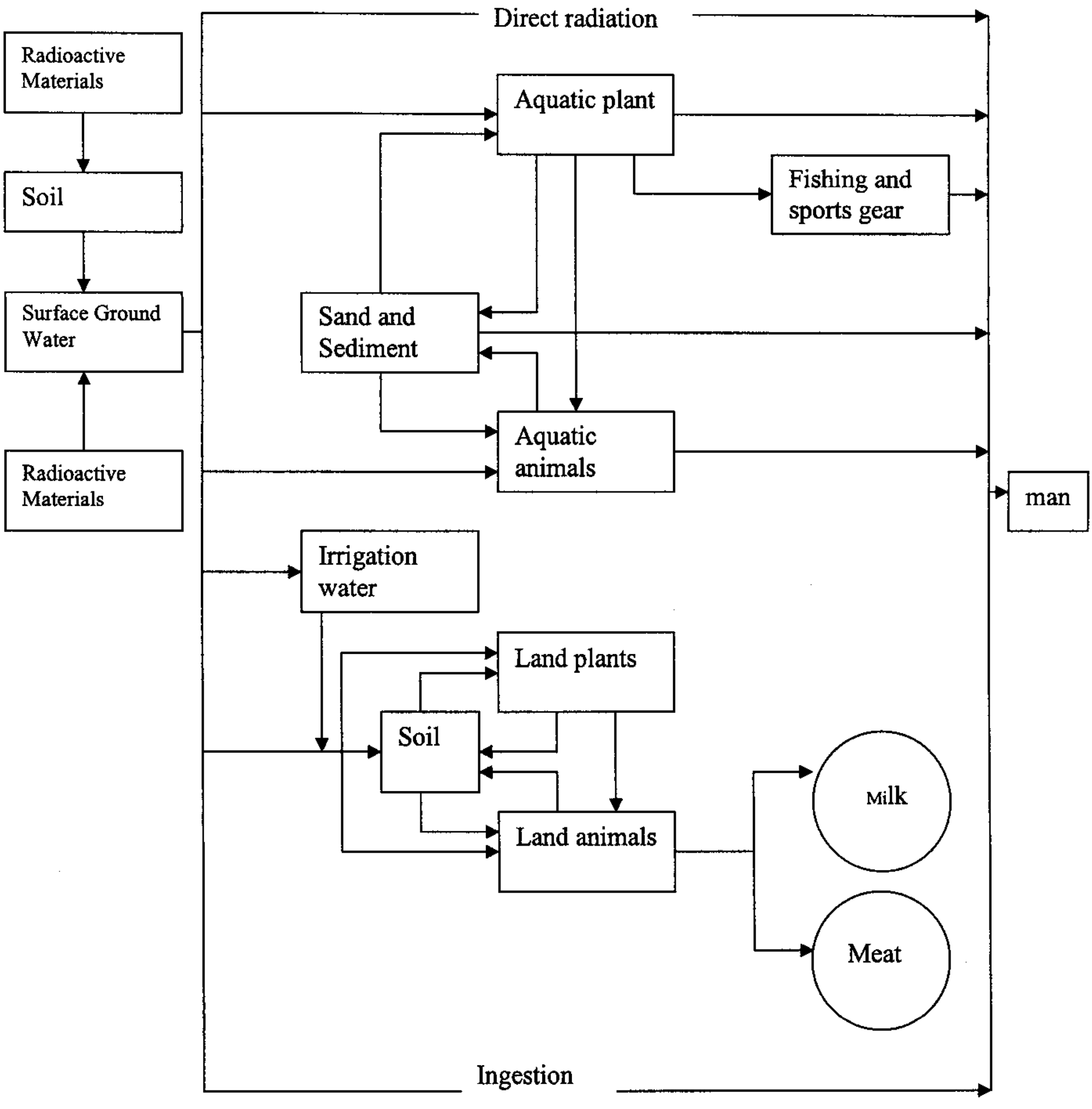

Fig. (1-4) Generalized liquid pathways to man

1.4 Site selection for nuclear facilities

Comprehensive studies have been carried out for El Dabaa area as considerable site for construction of the first Egyptian nuclear power plant. The main objective of selecting an appropriate site for nuclear facilities is the protection of nearby population against radiological impact resulting from any uncontrolled release of radioactive materials during normal operation of facility and that may be result from accidental release of toxic materials to the surrounding environment. In evaluating the suitability of any nominated site to locate a nuclear facility, several parameters need to be consider including; effect of external events occurring in the region of a particulate site, which may be either natural or man induced origin; the characteristics of the site and its environment, which could effect on the transfer of released radioactive materials to human beings; the population density and distribution in view of the possibility of implementing contingency measures.

Sometimes one main factor such as safety or economy, or even the social aspects, may be consider of the highest priority for site selection decision, depending on the criteria adopted by national authorities. However, in selecting appropriate location, an integrated approach needs to be elaborated for proper evaluation of all factors which will enable the decision-makers to study the effect of each complex factor on the several other factors and to evaluate and select the most appropriate site. To deal with this problem, it is therefore necessary to consider the different factors and criteria adopted for site selection of nuclear facilities in different countries. (31)

On the basis of this survey, it would be possible to evaluate the different aspects required for planning natural site selection criteria in terms of allocation of the different resources in the area, as well as the sociological, environmental and ecological predictions concerning human demands and development in the region. To obtain radical solution to this problem, and in particular to find the relation between the different factors involved, it is therefore necessary to categorize the interrelated factors and related subfactors under a number of major complex factors (31)

The Major complex factors worth to be consider include; the site physical characteristic; the different engineering and economic consideration; environmental protection needs; expected nuclear hazards and the social impact in the area. Important among the most important factors for location of nuclear power plants is not only the population density and related distribution considerations, but also the economic aspect, aiming to minimize costs and maximize profits.

Two main categories of the interrelated phenomena are relevant for siting nuclear facilities, namely: i-the phenomena in which the surrounding environment and man made events will have an effect on facility, for example earthquakes, extreme meteorological conditions, air crashes and explosions, and ii- the phenomena related to influence and potential effect of the facility itself on living population in the area, their activities and nearby environment, especially on the population distribution, land use, atmospheric dispersion, fall out of effluents and their diffusion in aquatic systems. In certain cases, based on preliminary studies of sites and the prevailing conditions in the area, the nominated site may be ruled out because of significant probability of sever events against which, it is not possible to protect the plant, as in the case of faults and cavities in the underground formations. For other severe events, the design bases are determined against which the facility should be protected. In this process the parameters, which need to be represented in engineering terms, include the effects that the events may have on the facility which need to be seriously considered in the design phase. Detailed studies related to these phenomena need to determine the dispersion characteristics in both air and water in the area, so as to be taken as basis for prediction of the consequences of potential accidents and normal releases of radioactive and hazardous materials in the area.

Extreme natural events that may have relevance to the design of nuclear facility depend in particular on several parameters characterizing the ambient conditions such as temperature, humidity, and wind; as well as on certain phenomena, which rarely occur, such as tornadoes, earthquakes, surges, and flood (32). The extreme man induced events, on the other hand, which might be considered in the design of nuclear facilities include in principal, air crash, chemical explosions or poisonous clouds (33). For design consideration, both the expected and limited events need to be considered. On one hand, the expected events are usually evaluated by processing the bulk of available data using a number of statistical analysis techniques. There consist in collecting the data and selecting a proper probability distribution law and deriving a graphical relation to define the probability of each parameter and to evaluate the standard deviation in estimated conclusions. Given an acceptable probability, the extreme values in design basis may then be derived from the extrapolation of the collected available historical data. For limited extreme events; on the other hand, which are with low occurrence probability, the facility must be able to withstand such events without large radioactive releases.

In general, mathematical models can be referred to for evaluation and definition of the effect of several events, considering a number of functional variables. The design basis and related events are selected either on the physical limits appearing in a particular mathematical models as deterministic approach, or on the basis of the values of various variables which are expected to have very low occurring probability. In this concern, a combination of the deterministic and probabilistic approaches is usually considered in a combined and integrated approach. To develop an effective procedure for the proposed integrated approach in site selection investigations, six interrelated stage are considered and organized in a collective framework; including description of the nuclear plant type, size and purpose; a preliminary choice of different sites with detailed studies and related investigations; site selection process; site evaluation; plant site layout; site appraisal and final site selection. Fig (1-5), illustrates a simplified representation of the site selection procedures, summarizing the different stages in site selection investigations, the interrelated steps which need to be considered, and the interdependence of each stage on the other.

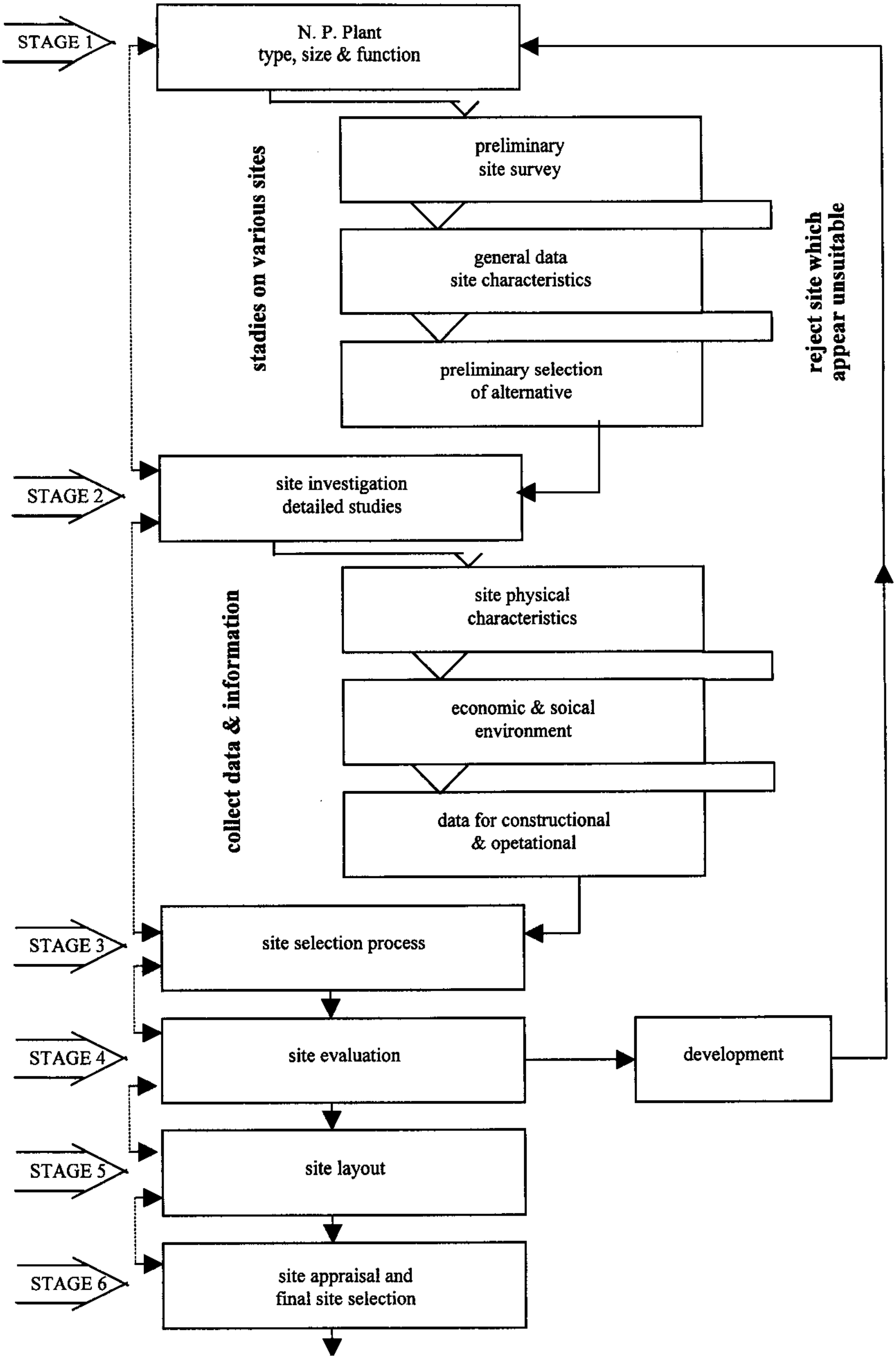

Fig. (1-5) Site selection scheme

This shows that there is a dynamic relationship between the factors influencing on site selection for nuclear power plant, and that decision making models depend not only on safety and economic consideration, but also on proper understanding of the impact of nuclear energy on the nearby environment.

1.4.1 El Dabaa site

The selection of El Dabaa area for construction of the first Egyptian Nuclear Power Plant was based on comprehensive site selection studies carried out in 1978-1979. Site selection and evaluation studies were performed through several investigations steps based on French regulation and practice (34)

The main reasons to select El Dabaa area include the suitability of the site topography which allows appropriate location and arrangement of the plant units with minimum constrains and good protection against sea hazards and flooding conditions; favorable soil characteristics; well-suited condition for the construction of the both the cooling water intake and discharge; absence of extreme weathering conditions; no surface faulting, low population density; low seismic probabilities; and good strategic location. The area has adequate infrastructure with alternative transportation conditions by road and rail; a 1000 mm diameter pipeline for fresh water supply. The natural and man-related hazards relevant to the safety of the nuclear power plant were quantified and found to be within acceptable limits, which are not expected to lead to any unconventional design requirements.

1.4.2 Site characteristics

El Dabaa town, is located in the coastal zone of the western Egyptian desert at the distance of approximately 130 Km of the east of Matruh the capital of the Governorate, and 160 Km of Alexandreia on the

Mediterranean Sea shore. The site area owned by the Nuclear Power Plant Authority (NPPA), lies between longitude 28 25-28 36 E and latitude 31-02 31-04 N, Fig. (1-6). It is extended about 15 Km (lying between 149 to 164 Km far from Alexandria) with one to three Km inland depth perpendicular to the shore-line.

1.5 Aim of work

This study deals with study of the suitability of site for the construction the nuclear power plant to make comparison between these results and those which might occur after construction and study the impact of power plant on the surrounding area to establish the radiological. baseline. To achieve this purpose, the study is subdivided into two parts, the first one deals with study of the radioactivity in the environment and the second part, study of hydrochemistry of water resources.

Generally, at the site selection of any nuclear power reactor the distribution pattern at both natural and anthropogenic radionuclides is an essential for evaluation and control of public exposure. The measurements of natural radionuclides U-238, Th-232 series and potassium in addition to artificial radionuclides as Cs-137 investigated to establishing the baseline map of environmental radioactiviy levels in view of construction the first nuclear power station. Measurements of those radionulides and subsequently the determination of the dose rate are needed to implement precautionary measures whenever the dose is found to be above the recommended limits. In addition to, study hydrochemical characteristics of surface and ground waters including chemical analysis of major, minor and trace elements as well as, measurements of stable isotopes (^{2}H, ^{18}O) which provide us by information about various parameters in the hydrological cycle, characterising water masses and their origin, interconnection of water bodies, and identification of recharge sources and recharge zones. Tritium used as environmental radioactive isotopes for the study of groundwater recharge and dating of groundwaters, identification of recharge sources and recharge zone, surface water & groundwater interaction, sea water intrusion.

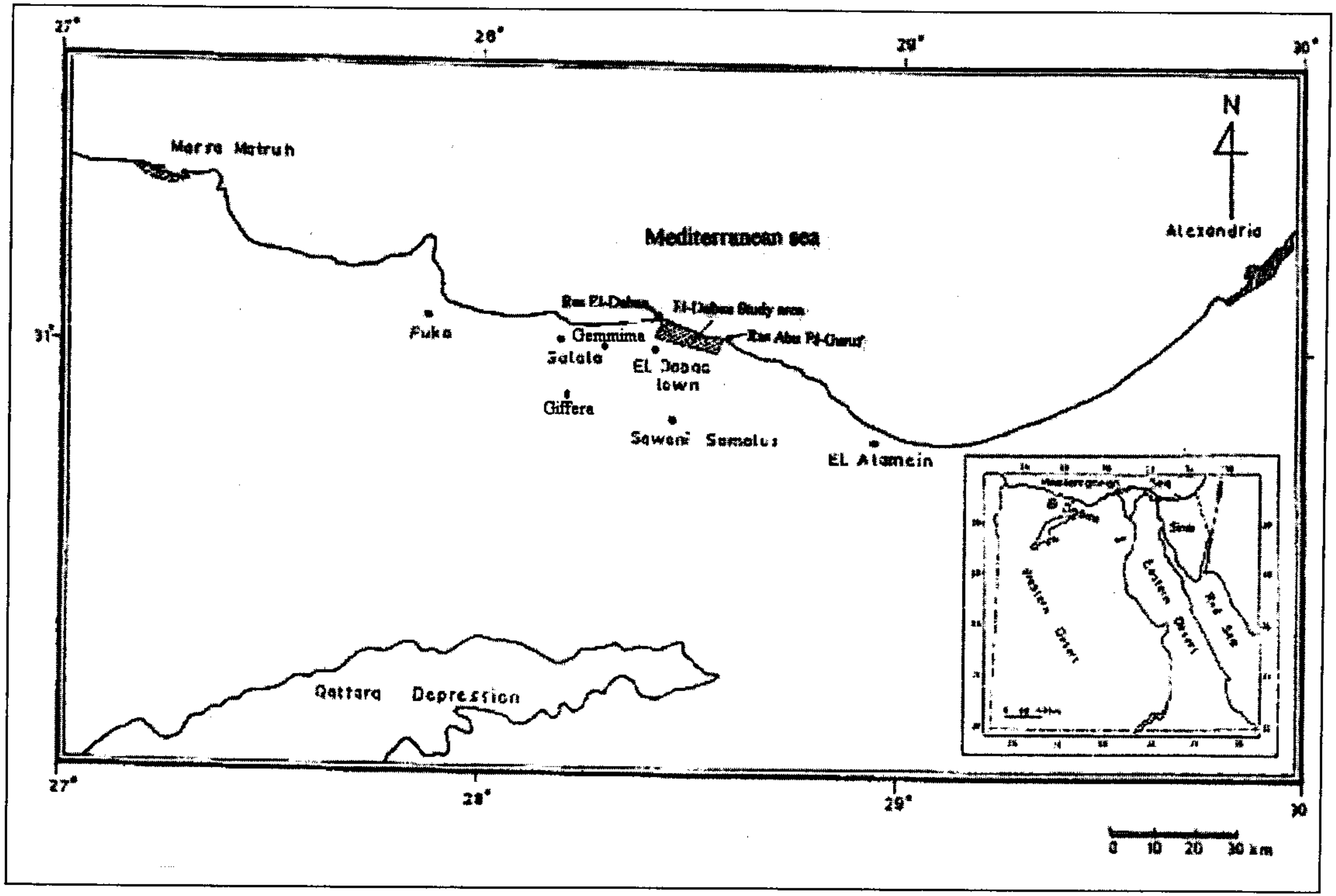

Fig. (1-6) location of El Dabaa site