ENVIRONMENTAL HEALTH RESEARCH IN JAPAN
- *MANAGEMENT OF ENVIRONMENTAL RISKS* -

by

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INTRODUCTION

The nature of environmental health issues of importance in Japan has gradually changed over the past decades and thus the research priority has also been shifted accordingly. The kind of serious industrial pollution incidents in the 1950' and 60' have long gone and any scene of resemblance of the time is very difficult to see today (Figures 1 and 2). The health damages inflicted then on people residing in the vicinity of industrial sites are also no longer typical. The damages then were direct, acute and extremely serious as in the cases of Minamata Disease, Itai-itai Disease, Yokkaichi Asthma, etc.

Throughout the 1970's and 1980's, the emphasis on environmental health issues has evolved from that pertaining to the cure of the damages already done to that pertaining to the cure of the damages already done to that on situation management, with increasing inclination toward environmental health engineering and planning.

The same trend seems to be persisting in the 1990', but with broader interpretation of and with greater sophistication in the concept of environmental health. Of course, the traditional discipline of public health, with particular reference to the environment, continues to be very important. Always, there appear new agents of concern to be assessed and managed by the public health discipline. Today, however, the causes of environmental

health deterioration are more diverse and are attributable to the societal activities as a whole rather than to specifically identifiable culprits. It is also getting more and more difficult to distinguish between human environmental health issues and ecological environmental health issues.

With the above in mind, the coverage in environmental health research in japan today, with particular reference to management of environmental risks, are discussed using the following categorization of subject areas of research interest.

EMERGING ENVIRONMENTAL HEALTH RISKS, THEIR ASSESSMENT AND MANAGEMENT

The world today benefits as well as suffers from the proliferation of synthetic chemicals. We benefit because our life-style is very much dictated by synthetic materials, or by chemical substitutes. In the process of manufacturing, use and disposal, some of the chemicals escape into the environment and expose to humans. The exposure to such a chemical may cause health risk in some cases.

More specifically, there are cases of chemical contamination and associated health risks never before experienced in japan. There was major industrial restructuring taking place in the 1970's and 1980's in which heavy industries located within industrial complexes such as steel and petrochemical industries were gradually replaced by high-technology industries such as electric and electronic goods manufacturing. These industries are typically much less water ad energy intensive than those sited in industrial complexes, and their siting near residential areas was not expected to be harmful to health. As it turned out, many of the chemicals used in these industries are chlorinated organics and are also suspected carcinogens.

Typical examples are organic solvents like tri-chloroethyrene and tetera-chloroethyrene. These chemicals are easy to escape from the site of use to the surrounding environments, particularly to the groundwater through soil. The groundwater contamination has quickly spread out throughout Japan at many industrial sites. In addition, even the urban groundwaters were found to be contaminated with the same kinds of organic solvents as those used in high-tech industries. The unexpected sources of contamination were the dry-cleaning operations, many of which are of small to marginal size.

A great deal of environmental health research has been undertaken in the past decade or so, with respect to identification of contaminant sources, determination of the degrees of contamination and development of mitigation measures. Some important breakthroughs have been made with respect to the extent of survey (e.g., the national survey), monitoring (e.g., development and application of monitoring instruments including development of portable monitoring kit), and remediation technology to restore the contaminated sites.

* ***Groundwater Management***

One of the areas having long been seriously neglected is groundwater quality management. The groundwaters used for drinking water supplies are to meet raw water quality requirements as specified in the revised water quality standards. The current legislation has no provision for groundwater quality protection except for the case involving soil contamination. The Agricultural Soil Contamination Prevention Law provides for standards on Cu, As and Cd, basically to prevent heavy metal accumulation in the crop. As for soil contamination in the urban area, the ambient standard set by Environment Agency in 1991 include, other than those set under the Soil Contamination

Prevention Law, Pb, Cr (VI), total Hg, CN, organic-P, PCB, based on what is called "the elution test", with apparent regards to prevention of groundwater contamination. The standards are, however, not the requirements but the achievement objectives and are difficult to enforce.

** Other Environmental Contamination Issues*

There are a large number of unidentified trace organic chemical compounds which contaminate air, water and soil, some of which result due to direct application like in the case of pesticide application on agricultural land or even on golf-links. While the biodegradable chemicals will eventually disappear, many tend to be bound in soil and gradually be released, causing concern for the prolonged contamination of groundwater and for the eventual health impact either through inhalation, dermal contacts, or by ingestion.

There are other groundwater contamination issues of importance. For example, the contamination of groundwater by nitrate nitrogen continue to be of concern in areas where drinking water source is in the vicinity of agricultural land. The fertilizer run-off from agricultural land eventually permeate through soil to contaminate groundwater. Because it is basically a kind of complex conflict between agriculture and urban land-uses, their resolution is often very difficult. It is one of the examples of contemporary environmental health issues which has to be dealt with broad participation of environmental policy bodies.

* *Source Protection*

As mentioned above, the contamination of air, water and soil, as exemplified in the case of contamination of groundwater by trace organic substances, is becoming a major environmental health issue, encompassing a wide range of social interest. For example, there have been talks of introducing a new legislation for the protection of water sources by resorting to such means as regulating specific types of contaminating activities, such as siting of golf-links, in the water source region as well as setting aside obligatory forest reserves. One of the potential stumbling blocs may the financing of such a major scheme. it will depend on the cost comparison between that and the introduction of advanced water treatment systems capable of removing trace organics to a significant extent.

* *New Drinking Water And Ambient Water Quality Standards*

As mentioned above, the concept of environmental health has evolved over the past decades from that emphasizing resultant health damages to that emcompassing both immediate and latent health risks. The trend is most apparently reflected in environmental health legislation such as the revision of drinking water quality standards, which now include a greater number of parameters with latent health risks.

The revised Drinking Water Quality Standards in Japan was promulgated in December 1992 and the revised Ambient Water Quality Standards was promulgated in March 1993. The revision of the former was since 1978. The original standard established in 1958 was revised in 1960 and 1966 before

then. The number of quality parameter items increased from 26 (1978) to 86. The original standard was established in 1971, with 8 water quality parameter items and it was revised in 1975 to add PCB. The current revision follows this 1975 revision to include 39 additional parameter items.

The revised Drinking Water Quality Standards has such new parameter items as;

i. inorganic substances: Se and Na.

ii. trace organic substances originating from high-tech industrial activities: 10 substances including tri-chloroethyrene, tetrachloroethylene and benzene.

iii. by-products of chlorination: 4 substances including trihalomethane.

iv. pesticides: 4 substances including 1-3 Di-chloropentane.
It also lowered parameter values of lead (lee than 0.05mg/I), arsenic (0.01mg/I), manganese (0.05mg/I) and anionic surfactant (0.2mg/I).

The revised Ambient Water Quality Standards has such new parameter items as:

i. Selenium.

ii. 10 trace organic substances originating from high-tech industrial activities.

iii. 4 pesticides.

In addition, there are 25 parameter items to monitor with guideline concentration values.

As for solid waste management, two new laws on solid waste management were passed in late 1992, one of which pertains to the management of solid and hazardous wastes (under the jurisdiction of Ministry of Health and Welfare) and the other pertains specifically to the reduction of waste amount and of promotion of recycling in the industrial sector (under the jurisdiction of Ministry of International Trade and Industry). The laws were revised also to make the definition of hazardous wastes containing chemicals consistent with the Basel Treaty parameter items.

SOPHISTICATION IN INSTRUMENTATION IN ENVIRONMENTAL QUALITY MEASUREMENTS

Because of the nature of such chemicals, transmedial among air, water and soil, their monitoring is becoming more and more complex and requires sophisticated instrumentation. One of the apparent trends in environmental health research in recent years has been on the development and application of monitoring instruments for the quantification as well as identification of these trace organic chemicals.

Industrial air pollution today is basically under control in Japan. A huge sum of pollution control investment has been made in the 1970's and 1980's and the stringent requirements in ways of resident-industry agreement seem to have made it very difficult for industries to lax the pollution control efforts. The amount of financial burden after pollution incidents, in terms of pollution victim compensation and regaining of lost corporate image, turned out to be much greater that the initial investment for installation of pollution control equipment.

On the other hand, the vehicular emission and the resulting road-side air pollution, particularly with respect to NO_2 has been getting worse in major metropolitan areas, due primarily to the increase in the number of automobiles.

For this reason, the extent of human health risk to the roadside residents and pedestrians in one of the research areas drawing significant interest. For example, the rate of inhalation and the extent of health impacts of SPM can be determined using personal dust samplers on which dusts could be collected at various urban sites. The potential health risk of the collected dust could be determined, for example, using a combination of instruments for such purposes as measurement of chemical components distribution, detection of free-radicals and determination of mutagenicity.

In cases of water and soil contamination, as well, instrumentation with respect to multiple and simultaneous measurements of environmental quality parameters is becoming more and more important because of the increase in the number of quality parameter to measure and their combined health effect, as already mentioned above with regard to the requirements specified in the revised drinking water standards. As for instrumentation for rapid measurements of environmental quality parameters, recent literature include such examples as:

- Chl-a profile measurement by laser technology.
- odor sensor for control of small scale treatment systems.
- polycyclic aromatic hydrocarbon detection by blue-rayon method.

HAZARD AND RISK ASSESSMENT AND CONTROL

The monitoring of new environmental parameters has added a whole new dimension to the concept of environmental management in the past decade or so. The general public is growingly aware of the latency of health impacts of some of the chemical pollutants. many environmental health researchers today, therefore, engage themselves in the study of health hazard assessment and control represented by such expressions as genotoxicity, mutagenicity, eco-toxicity, etc., in various environmental settings. Some of the specific research areas in recent literature include:

- the use of biological indicators such as yeast, algae (i.e., growth inhibition indicators), sea urchin, etc.

- genotoxicity measurement such as by Ames test, umu-test, Recassay, etc., and cytotoxicity in general.

- the use of culture cells on a photolithographic plate.

- detection of mutagenicity using mussel Mytilus edulis.

- eco-toxicology as an instrument for monitoring reduction of toxic waste emission, such as that of Butyltin compounds.

In addition, the applied research on genotoxicity of organic substances have also become quite popular these days. The examples in this area include:

- dioxines generated in production and treatment systems.

- genotoxicity of organic substances in municipal sewage ad its ozonated products.

- DNA toxic pollution in water environment in general.

- organic halogens and mutagenicity of drinking water disinfectants.

- aldehydes in advanced water treatment processes.

Establishment of methodological framework for human health risk assessment, ecological risk assessment as well as hazard assessment and control of environmental contaminants will continue to be of major research interest for some time to come.

Many of the micropollutant issues, however, can be regarded as being linked with general environmental issues such as control of run-of from urban and non-urban sources of waste loads. The traditional areas of research on reduction of wasteload from domestic, industrial, dairy and agricultural sources, as well as prevention of eutrophication, therefore, continue to be very important, because many of the micropollutant coexist with such conventional sources of pollution. Thus the research activities on removal of N and P from wastewater as well as measurement and control of nonpoint run-offs, continue to be quite important not only from the point of view on environmental pollution but from the point of view on health and ecological risks.

The research activities pertaining to the above notion may include such research subjects as using microcosmic environments, development of bioassay systems resorting to such living creatures as Moina macrocopa, ecotoxicity

measurement using immobilized Daphnia magna. Regardless, the accumulated findings will sooner or later have to be linked to the development of a management policy of chemicals not only on a national level but also on a regional and even basin-wide level, if site-specific plans are to be developed to contain such mutagenic and eco-toxicological agents in the environment.

TECHNOLOGY DEVELOPMENT IN ENVIRONMENTAL HEALTH RISK MANAGEMENT

Though most of the chemicals used have insignificant health impacts, there are a growing number of chemicals which are considered to be toxic. Pesticides applied on golf links and paddy fields have already been mentioned. The management of such risks, including that resorting to technological solutions, will continue to be an important consideration today and in future.

For example, the leachate from solid waste disposal sites contain high concentrations of toxic chemicals. If located in the vicinity of drinking water sources, such chemicals are bound to contaminate the source water. Similarly, many microcontaminants such as viruses, carcinogens, mutagens, etc., are found in the wastewater. The treatment effluents which are released in the receiving water bodies may be potential health and ecological hazards in that respect. Although many different treatment technologies are available, they may not be used because of high cost. Development of cost efficient treatment technologies, therefore, is an important environmental health research subject. Technologies are being developed in recent years in trace contaminant detection including bioassays, removal and mitigation including biological detoxification and treatment and remediation including in-situ methods of removal of trace organics from underground. Some of the examples of research subjects include:

* ***Remediation Of Contaminated Soil***

- soil excavation, gas extraction and groundwater pumping.

- bioremediation.

* ***Ultra Membrane Filtration***

- As applied to purification of domestic and industrial wastewaters including that containing virus, trace chemicals such as phenols.

- Often in combination of other unit processes such as activated sludge process.

- Applied to other high concentration wastewaters such as landfill leachate.

* ***Advanced Water Treatment Processes***

- system development and improvement for tri-halomethane removal from drinking waters.

- UV radiation applied for decomposition of chlorinated organics, phytoplankton control.

- disinfection and decomposition of organics by ozonation as applied for treatment of drinking water, river water, landfill leachate, etc.

- improved ozone generation technologies such as by photochemical reaction.

OTHER OBSERVATIONS

Despite all the above issues of current concern and research interest, there are conventional environmental health concerns still to be closely followed. Some of the issues falling in this category include health impacts o heavy metal intake, respiratory diseases cause by air pollutants such as TSP, So_x and NO_x, etc. Other issues of interest include the following.

- fluidized-bed biological activated carbon system as applied to purification of household gray water, direct purification of drinking water, treatment of process wastewaters such as dyeing, treatment of leachate from landfills.

- removal of suspended algae, e.g., Microcystis, by in-situ coagulation units.

- enhancement in nitrogen removal efficiency from domestic wastewaters, by such methods as sequencing batch reactor, biological NH_4NO_2 production, biofilm electrode, etc.

- innovated wastewater treatment technologies applied to smallscale treatment systems, e.g., filtration-aeration-trench (FAT) method, rotary magnetic-disks.

- bioluminescence assay as applied to control of biological wastewater treatment system.

- esturine coastal beds including artificial beaches as treatment media of contaminated water.

- decomposition of LAS compounds, phenols, chloro-ethyrenes, phthalic acid esters, etc.

- recycling of treatment plant sludges.

- use of fiber media for in-situ water quality improvement.
- evaluation of treatment efficiency through bio-assays.

At the same time, there are aspects of environmental health subject mentioned above which are not dealt with in detail in this paper. They include, for example:

Cost-efficiency (e.g., optimizing the design of devises, instruments and systems with advanced control technologies), detection levels (e.g., refined analytical methods with new monitoring and detection instruments), flexibility in application (e.g., higher level of control for fine adjustments in treatment levels) and meeting ever-growing consumer on environment-friendly products (e.g., product liability), environmental health aspects of new products (e.g., environmental health aspects of household goods such as portable water purifier), resource conservation and reuse (e.g., cleaner products, waste exchange), etc.

One of the areas worth mentioning is that there has been a growing number of research projects for developing better partipatory methods and for assessing their effectiveness. There have been reports on attempted experimentation on development of alternative social systems where citizen needs and interests could be captured more correctly and efficiently, an example ow which include a system of household expense management based on environmental accounting.

Aside from the categories of issues on environmental health mentioned above, there are non-hazard environmental health issues drawing greater research interests such as taste and odor removal, color removal from wastewater, noise an vibration etc., with combined efforts in technology development including search for appropriate and low-cost technology. In addition, great interest has been shown in the new types of environmental allergies, such as pollen-induced allergies in combination with air pollution as we as household environment and allergic incidents.

CONCLUSION

According to some retrospective analysis of environmental health issues of the 1960's and 1970's, the residual impacts of health damages of the past still remain for many of the pollution victims, despite the fact that ambient condition may have attained significant improvement.

In many respects, the level of environmental pollution in Japan today is of course much less severe than before. The conventional water, air and solid waste management issues are dealt with more or less satisfactorily. With the improved environmental condition, the health status of the population has also been improved. The life expectancy of the Japanese has been extended over the years to the point where it reached the very top among the nations (Figure 3).

Whether or not it means we have better quality of life, however, is a quite a different matter. The definition of the cleaner environment today is different from that of the past. There are certain other types of pollution which

emerged out of the proliferation of chemicals and in turn there are more incidents of chemical pollution. The industrial restructuring in the past decades also contributed greatly to contamination of soil and groundwater contamination not experienced before.

The environmental pollution today, therefore, is in much different from than in the past but it is not less serious. The incurred health damages today are not as apparent, direct and immediate as in the early days of environmental pollution, but they are more widespread, compounded and latent. The environmental health research. therefore, must accommodates for such pollution types, be they on identification, measurement or mitigation. The very basis of that is the accumulation of health risk assessment data and their application to institutional development, technology development, planning and management which must continue to receive great emphasis in the coming years.

This paper is not meant to have a comprehensive coverage of environmental health research in Japan but to provide the basis of discussion on the subject from many different perspectives. It is hoped that the paper will serve as a useful contribution to the discussion forum.

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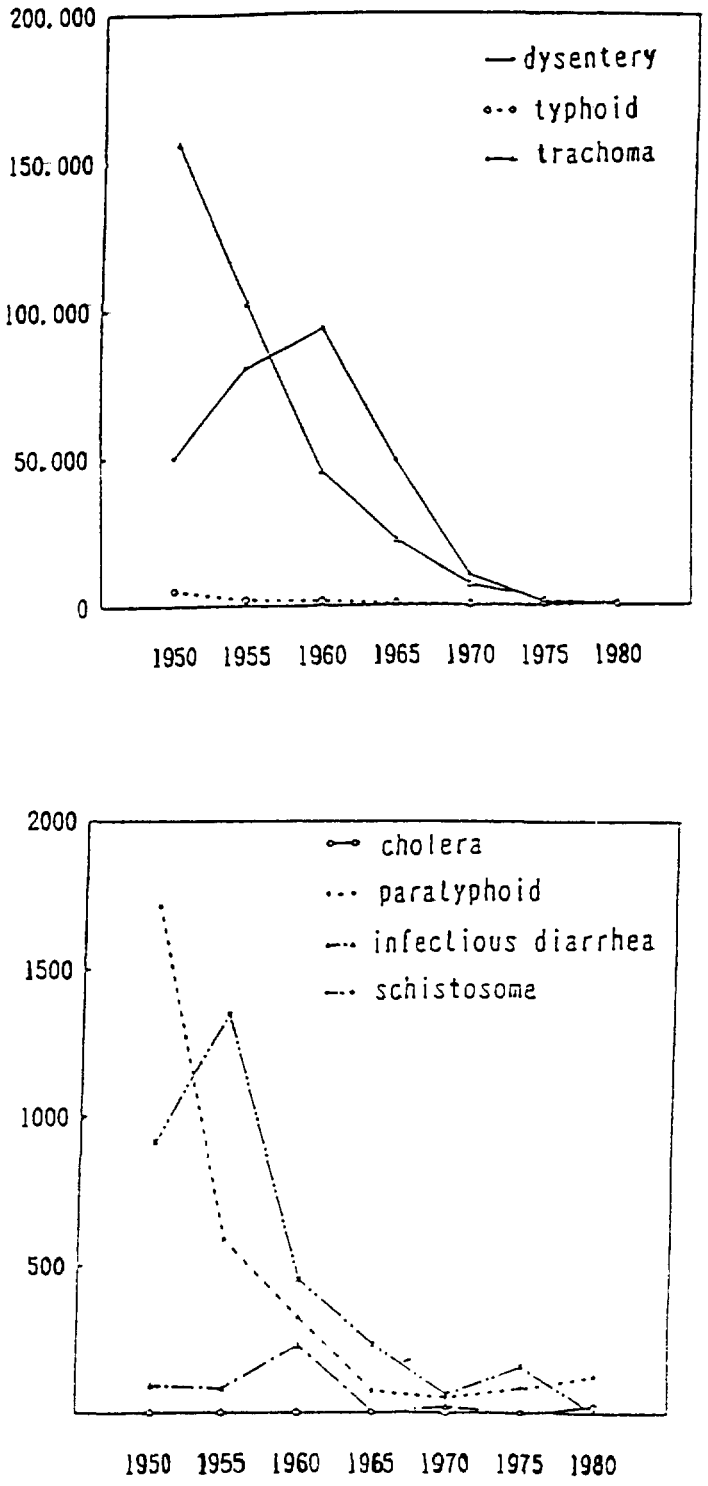

Figure 1 Cases of Waterborne Disease 1950-80

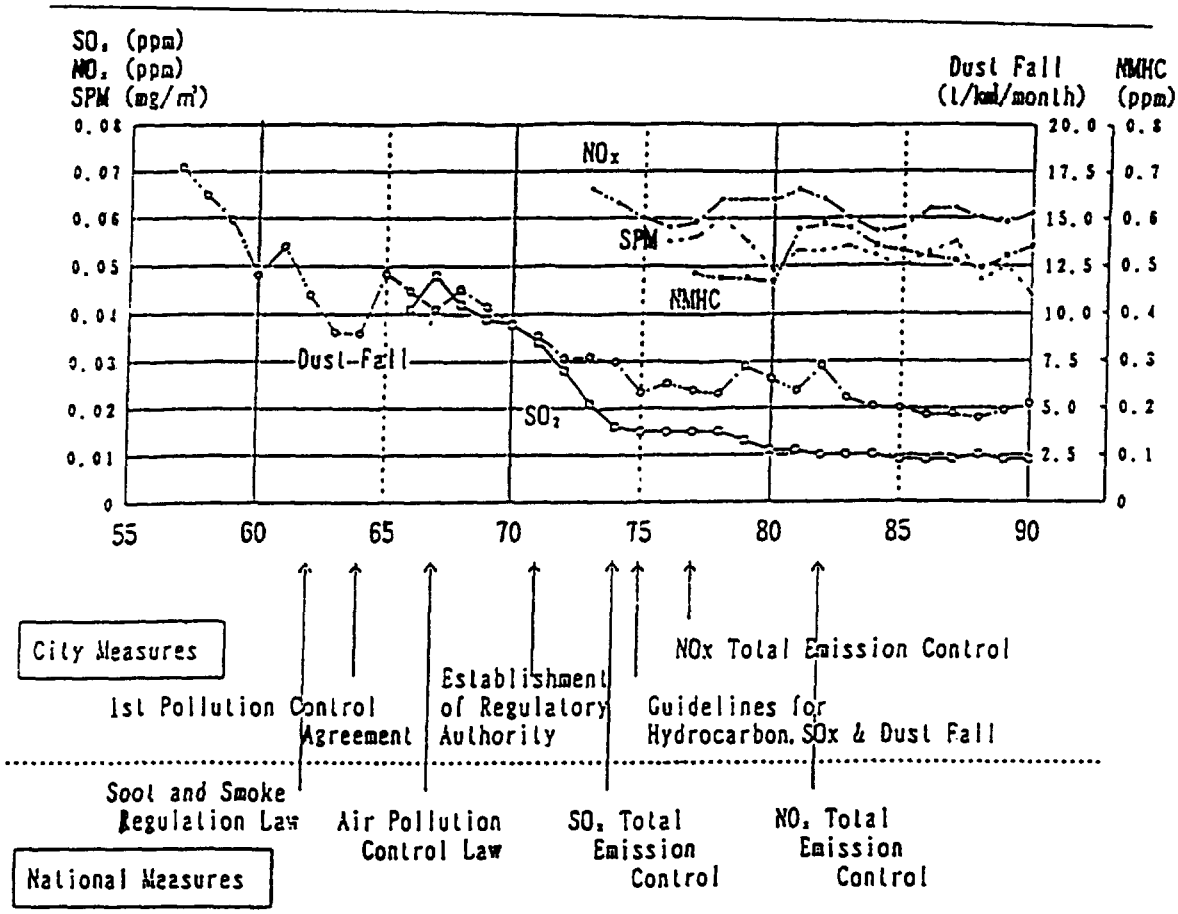

Figure 2 Ambient Air Quality : General Environmental Monitoring Stations. 1955-90

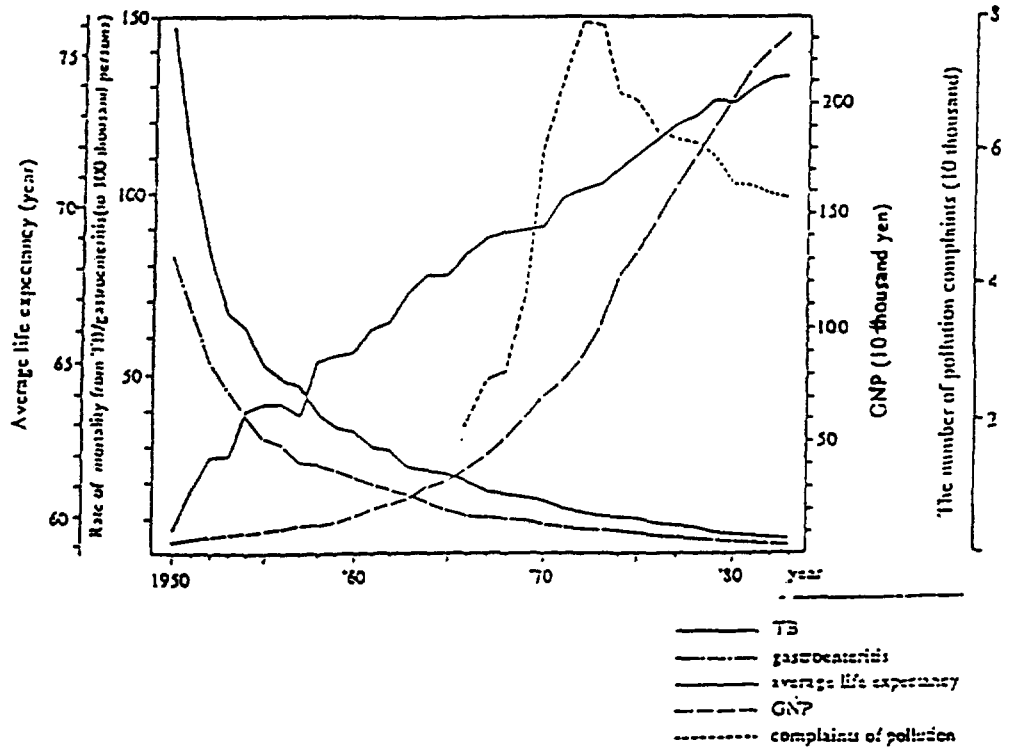

Figure 3 Life Expectancy and Cases of TB and Gastroenteritis 1950-80